Littoral Combat Ship (LCS) Characteristics Task Force

Final Report

31 July 2002

CDR Carl Carlson
Bradd C. Hayes
Hank Kamradt
with
Gregg Hoffman

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
31 JUL 2002		**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Littoral Combat Ship (LCS) Characteristics Task Force	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval War College,Newport ,RI,02841**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**71**	

Littoral Combat Ship (LCS)
Characteristics Task Force
Final Report
31 July 2002

CDR Carl Carlson
Bradd C. Hayes
Hank Kamradt

with

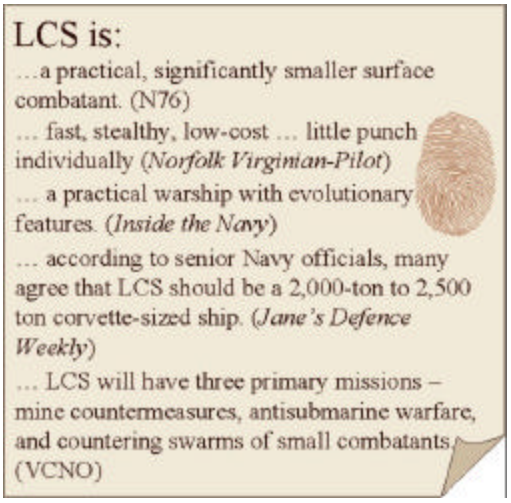
Gregory Hoffman

INTRODUCTION

Tasking

In December 2001, the Navy Staff's Director, Surface Warfare (N76), requested the Naval War College's assistance in defining the characteristics that should be used and the technology opportunities available when constructing a littoral combat ship (LCS) — the smallest member of a new family of ships being developed by the Navy. The tasking was driven by an ambitious schedule that precluded a zero-based study; therefore, the Naval War College assembled a multi-disciplinary team of subject matter experts to examine current and proposed programs from which they gleaned the most promising ideas. The process began with a core group that met in Newport, RI, in March 2002. This group approved characteristic guidelines and constraints (detailed below) and selected primary and secondary missions that littoral combat ship variants should perform. The initial workshop was followed by a series of workshops that drilled more deeply into the characteristics that the LCS should possess for each mission area. An integration effort took the data gleaned from these workshops and merged them into options presented in a draft report. A final LCS characteristics integration workshop was held 26-27 June 2002 during which the draft report was reviewed and options refined. Results of that workshop are incorporated into this report.

Task force members were asked to take an "open and honest" look at all options. They found, however, that the proverbial "clean sheet of paper" they were given was not entirely free of fingerprints and more were added as the process advanced. Although we were aware of all the opinions and options on LCS that were being discussed, including at the time of the integration workshop a list of characteristics purportedly for the Flight 0/Baseline 0 LCS (see Appendix A), we continued to operate in as honest and independent a manner as we could. Even before receiving the Baseline/Flight 0 characteristics list, participants



understood that some options were unavailable to them. Nevertheless, they pressed forward and examined a broad array of options. One constraint participants knew would not change was affordability.

Prior to the initial workshop the Commander, Naval Surface Forces Pacific, released a message providing his thoughts about the littoral combat ship. His representative was provided an opportunity to discuss the message early in the March 2002 workshop and it served as a straw man concept during discussions. The message can be found at Appendix B.

The mission areas selected during this initial conference were then explored more deeply in follow-on workshops. The tasks proposed and prioritized by mission area workshop participants are found in Appendix C. The principal take-aways from these workshops are found in Appendix. D.

Multiple options examined

It became abundantly clear as the workshops progressed that no single LCS concept was going to satisfy everyone who had a dog in the fight. Three distinct camps emerged during the workshops with each camp supporting a different, but highly credible vision of what the LCS should be. Supporting the first variant are those who continue to see the LCS as a multipurpose ship that can be used to carry unmanned (often autonomous) warfighting equipment into the theater and then rely its speed to move out of harm's way. Under this concept, the LCS is the sea base for deployed (that is, offboard) sensors and weapon systems. Proponents of this concept envision few, if any, organic weapons systems and sensors carried on the ship. They point to the experimental High Speed Vessel (HSV) as a good first step approximation of the ship. We call this "Type A" LCS.

Others see the LCS as a stealthy, fast, maneuverable, but smaller than the other variants, vessel that can go toe-to-toe with littoral challenges. Proponents of this option favor a ship that carries a very small crew (30 to 40 personnel), no helicopter detachment, and fly-in modules which are accompanied by the crew to man them. We call this "Type B" LCS.

Finally, there are those favoring a larger-sized ship that possesses some of the characteristics of both Types A and B, but with more robust indigenous capabilities than either of those concepts envision. This group favors the LCS carrying an organic helicopter, a small multipurpose modular launcher, a medium/small caliber gun, an active/passive sonar (probably towed), a multi-function type radar, and unmanned systems as they become available. We call this "Type C" LCS.

Support for each of these types remained firm, even during the final integration workshop. As shown in the attached data, participants at the final workshop confirmed what we found during the mission area workshops; namely, the "Type C" LCS is the preferred choice if only a single variant is going to be pursued. This is because Type C has more capability and fewer endurance, payload, and sustainability challenges than the

other two types. In addition, Type A and, to a lesser extent, Type B are primarily conceived to support systems that are currently unavailable. Type C would provide acceptable near-term (transitional) capabilities as well as a platform designed with transformation and future growth in mind. Participants referred to it as "the 80 percent solution."

The following data was gathered when participants were asked to rank order LCS variants if one, two, or all three were pursued. Nearly 60 percent of the participants would first pursue a Type C variant, while Types A and B were favored by approximately 20 percent of participants as their first choice. Type A might have been shortchanged in the vote since we had labeled it a "truck" and some participants argued as such it should not even be considered an LCS variant, but a logistics ship. Arguments to the contrary were made, but labels are powerful. We explained that the term "truck" was descriptive and not meant to be pejorative.

Rank Sum

88	1. Type C
68	2. Type B
60	3. Type A

Number of Votes in Each Rating

	1st Choice	2nd Choice	3rd Choice	Mean	STD
1. Type C --	21	10	5	1.56	0.73
2. Type B --	7	18	11	2.11	0.71
3. Type A --	8	8	20	2.33	0.83

If designing a small capable ship were not difficult enough, the missions that workshop participants assigned to the LCS (as discussed below) involve tasks that have historically proven immensely challenging to the Navy. These challenges remain immense and trying to tackle all of them with a single type of ship, especially a very small ship, stretches credulity — even with new technologies. Based on LCS mission characteristics, we believe there is considerable merit in continuing to consider all three types of LCS for the following reasons: Type A can be fielded quickly and operating it can help answer a lot of questions about the value of speed in mission performance and the benefits or drawbacks of alternative hull forms. Type B would primarily be used to support special operations, near-shore surface warfare, and maritime intercept operations — missions where stealth, small size, and speed pay particularly high dividends. Type C gives the Navy a ship that can bolster fleet end strength (one of the CNO's goals) and work with or independent of battle groups. We believe that LCS Type C will become a real workhorse of the future Navy and the focal point of coalition littoral operations.

Even though we continued to see three separate variants described during the integration workshop, we were not supported by participants in our conclusion that all three variants should be pursued. They voted (as shown below) to recommend pursuing two variants vice three (dropping Type A for the reasons noted above). Participants also believed the Navy would find it politically infeasible to pursue all three variants. We asked

participants to rank order their preferred course of action: one ship, two ships, or three ships. As can be seen, all participants made pursuing two variants either their first or second choice.

Number of variants to pursue	1st Choice	2nd Choice	3rd Choice
Two ships	17	19	0
Single ship	14	12	10
Three ships	5	5	26

The remainder of this study reports the findings of the initial, mission area, and integration workshops.

INITIAL WORKSHOP

In order to stimulate thinking, participants at the March 2002 workshop were asked four questions that examined the reasons the littoral combat ship program sprang to life.

Question 1. Is the littoral combat ship a mission/capabilities focused frigate or corvette-sized ship optimized for littoral environments?

The simple answer to this question is yes. The task force was formed to help the Navy design a ship. The question is why? The Chief of Naval operations has established the goal of a 375-ship fleet — approximately 100 more than current ship plans support. Without a small, affordable ship that 375 figure is unreachable. As we understood the tasking, the CNO does not want 375 ships that are so small they are incapable of contributing to the Navy's forward presence mission, nor so lacking in capability that they must be kept from harm's way. The bottom line is that the littoral combat ship must help the Navy increase its force structure and be capable of satisfying some forward presence requirements.

Question 2. Is the littoral combat ship a very small displacement, advanced technology vessel?

If the answer to question one is yes, then the answer to this question must be no. Unfortunately, the matter is not that simple. The littoral combat ship became the darling of Congressional and military reformers because they were swayed by Vice Admiral (ret.) Arthur Cebrowski's arguments in favor of the *Streetfighter* concept, which envisioned a small, fast, networked vessel that could operate effectively in the littorals. They believe that a ship, in order to be transformational, must look, move, and act very differently than ships of the past — and, most importantly, it must be fast. The CNO is on record favoring a minimum 50-knot ship. Regardless of the size of the LCS, it must satisfy those who will only believe the Navy is transforming when they see it sail something radically new. That notion segues into the next question.

Question 3. Is the littoral combat ship an answer looking for a question?

Since the littoral combat ship was being discussed before a mission for it was determined, some would answer this question in the affirmative. LCS may be a way to scratch the itch of military reformers in order to silence critics who insist the Navy has failed to develop a transformational road map, but that begs the question of why the Navy must transform. Surely the expeditionary nature of the naval service shouldn't change; after all, the Army and Air Force are being lauded for becoming more expeditionary. On the other hand, real operational shortfalls associated with littoral warfare exist in the current force, and one compelling alternative to deal with those gaps is to explore the potential of a new ship designed for littoral conditions.

Question 4. Is the littoral combat ship a set of access capabilities that can be addressed by several types of surface ships/vessels, or by platforms other than ships?

There is a growing consensus that operational shortfalls do exist. That does not mean, however, that answering this question affirmatively requires one to answer question one negatively — they are not mutually exclusive. In fact, one of the keys to keeping LCS costs down will be to leverage its capabilities by exploiting weapons and sensors carried by other ships or platforms (including unmanned systems carried on the LCS).

Following the philosophical discussion engendered by these questions, participants were exposed to an array of program options and operational alternatives to help them understand what missions might prove practical for such a ship. Although several participants wanted to jump directly to mission area discussions, workshop facilitators felt that exposing them to operational alternatives would make the mission discussion richer and broader.

HOW MANY PROGRAMS SHOULD THE NAVY PURSUE?

Participants were asked to considered the possibility that more than a single variant should be pursued. We asked this question because there were three prominent concepts of operation being pushed by various factions in the Navy. Although three options remained prominent throughout the process, the options changed significantly as the various workshop discussions proceeded. *The options presented at the initial workshop were not the same options presented at the integration workshop.*

Option 1. Single ship.

A single ship option suits the N76 tasking, but if operational shortfalls are a real driver for the program, a single ship might not provide the Navy with the flexibility and capability that it needs. This can be somewhat mitigated by ensuring the ship is not a single-mission ship. The more missions a ship can sequentially perform, however, the larger its size. Size, in turn, affects speed, and the larger the ship the more difficult it becomes to generate a high top end velocity. Size also affects cost. The pressure was obviously to keep the ship small.

Option 2. Two ships.

There are honest differences of opinion about how the LCS should operate. Some people expect it to enter the littoral and remain there to fight. Others believe it should only dash in to perform a quick mission — such as dropping sensors or offloading special forces — and then dashing quickly back to a safe distance. One group favoring this concept of operations sees the LCS operating much as an aircraft operates off of a carrier; even changing crews after each mission if required. The "stay and fight" and "dash in/dash out" visions of LCS are probably mutually exclusive and satisfying both requires the development two different ships.

Option 3. Family of ships.

Critics of a small craft approach trumpet the past challenges the Navy has confronted when trying to keep ships like PHMs and MCHs forward deployed (or even homeported overseas). Some believe that a scheme involving a large LHA-type ship that carries a number of different platforms is the best way to overcome current operational shortfalls, avoid past challenges that confront small vessels, and still demonstrate a commitment to transformation. A scheme based on a so-called "mother ship" fails, because of cost, to satisfy the CNO's desire to increase force structure significantly. As a result, this concept was quickly replaced by a concept favoring a ship based on the experimental High Speed Vessel.

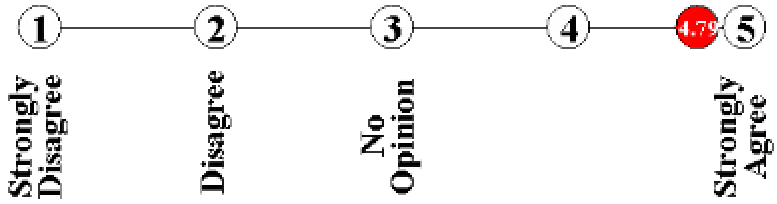
As the initial workshop proceeded, there was a growing sense that a single ship-type would have a difficult time satisfying all operational requirements. This question, therefore, remains an open issue. Many of the questions surrounding a single ship-type, especially if it is a small ship, involve the special logistics support it would require and/or the need for overseas ports and all that entails. These issues will be discussed later in the report.

WHAT GUIDELINES SHOULD DIRECT MISSION AREA WORKSHOPS?

Participants were presented with a series of macro guidelines that could be used to start the narrowing process. Some participants bristled that these guidelines were considered before the question of what missions the LCS should perform. The guidelines were designed to provoke discussion as opposed to representing a *fait accompli* decision about ship design. As a result some were changed during the course of the discussion before being approved. In order to determine a sense of agreement, participants were asked to rate their feelings on a five-point scale from strongly agree to strongly disagree (with strongly agree rating a 5 and strongly disagree rating a 1). Results are shown below. The approved guidelines were used during all subsequent workshops and, as will be evident from the results of the integration workshop discussed later, were followed.

Guideline 1. The ship must be capable of networking with other platforms and sensors.

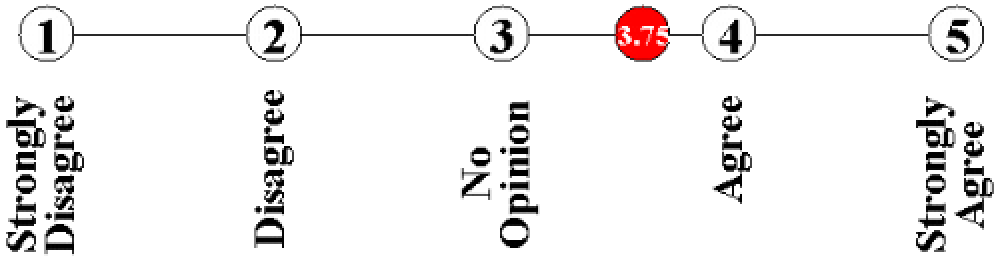
The Navy has declared that network-centric warfare is the transformational touchstone that guides all new system acquisitions. Although there was strong agreement that networking was the *sine qua non* of the littoral combat ship, there was a sharp division between those who believed it must be fully networked to all systems and those who believed it only needs to be connected in areas directly affecting its mission performance. There was agreement that the LCS must be both a user and a provider of sensor data.



As the vote demonstrates, there was unanimity that mission area workshops needed to consider how networking could be used to conduct LCS missions.

Guideline 2. The ship must be useful across the spectrum of conflict.

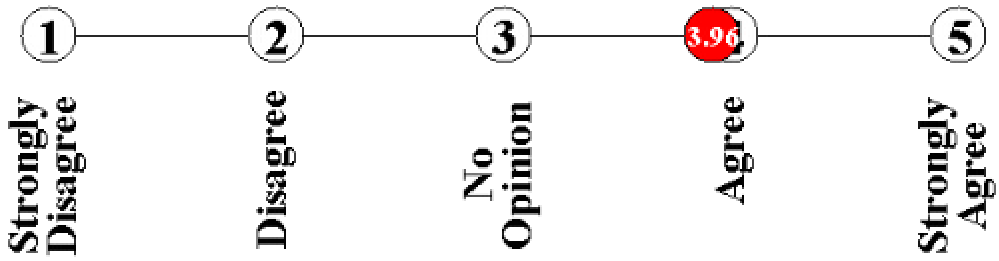
The rationale behind this guideline is the belief that the ship must play an integrated role in both the Navy's combat and peacetime operational concepts in order to maximize its value to the service and nation. Although the ship is being designed to address operational combat shortfalls, most of its service life will be spent supporting peacetime operations. Even though participants agreed with this statement, they didn't want this statement to imply that the ship should be a jack-of-all-trades. They believed it should be able to conduct peacetime exercises, maritime intercept operations and similar missions in times of tension, as well as carry out its wartime roles.



The vote shows approval, but greater disagreement, than with the first guideline. Most of those who disagreed with the statement were concerned with the term "spectrum of conflict" — believing it implied the LCS would be a general rather than a specialized combatant, thus dramatically increasing its size and cost. Mission area workshop participants were advised of this concern and were admonished to concentrate on combat requirements.

Guideline 3. The ship must be able to contribute to sustained forward naval presence.

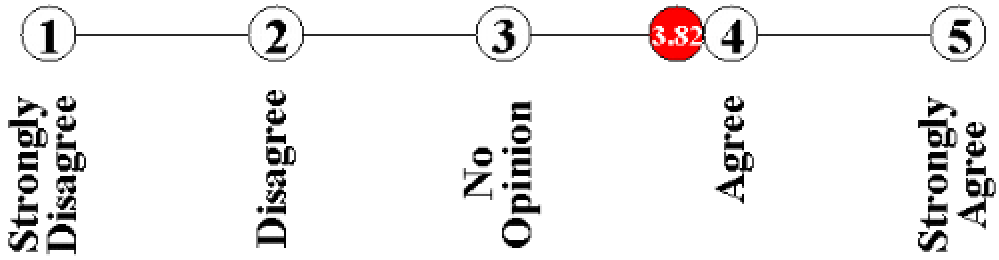
Most participants agreed that unless the LCS can take its place in the deployment rotation, it becomes a burden to the rest of the fleet rather than a force multiplier. It also fails to achieve the real purpose behind the CNO's objective of having a 375-ship fleet. Those who didn't believe that the LCS must be capable of deploying with the battle group argued that it could be stationed forward. Appendix A indicates that the Navy staff believes the ship should be able to remain forward for up to three years.



The vote shows that there was good agreement that the LCS must contribute to the Navy's forward presence mission.

Guideline 4. The littoral combat ship logistics support, especially unique requirements, must be included in each mission area discussion.

Many small ship concepts on the table advertise they are self-deployable. Physics, however, undermines the rhetoric. Very small ships can deploy, but require frequent refueling and carry few if any weapons. A ship reporting on station with neither fuel nor weapons, and that requires frequent servicing (and maybe even a dedicated support ship), is more of a burden than an asset on already stretched support forces. Nevertheless, if the information in Appendix A is accurate, the Flight 0 ships are expected to deploy without a payload, making logistics support a serious question. Most participants believed a smaller LCS would require special handling (including special support ships or overseas bases) in order make it as flexible and sustainable as it will need to be.

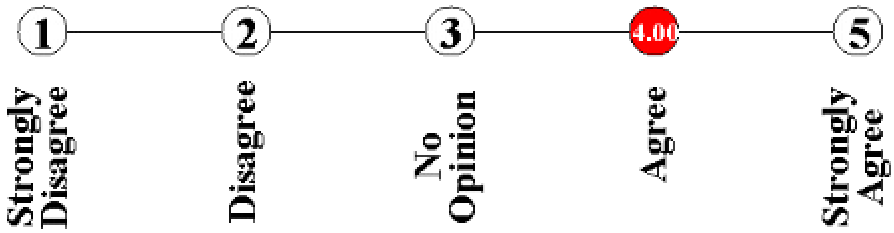


Participants eventually fell into two camps, each supporting a different size of ship. Hence, it was not surprising that those supporting a smaller ship would argue against factors that undermine their favored position. They insisted that if a small LCS was the right answer, then investing in an appropriate logistics train to support it was also the

right answer. Since the N76 representative had indicated in his opening remarks that a separate class of support ship was not in the offing, participants agreed eventually that logistics were an important challenge for further discussion.

Guideline 5. The ship should be capable of operating manned vertical lift aircraft.

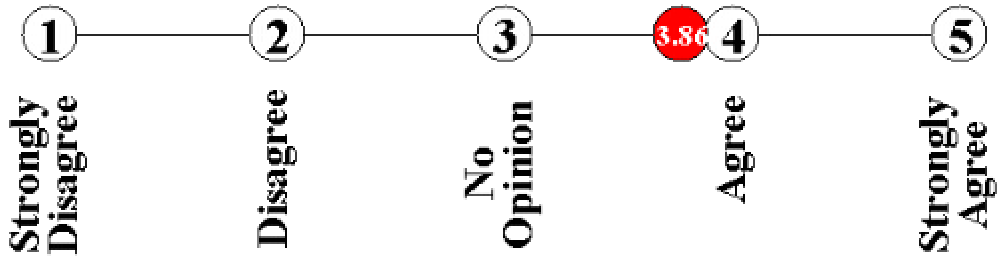
Both mission requirements and common sense underpin this principle. Vertical lift aircraft can extend surface ship sensor and weapons reach as well as facilitate at-sea support. Originally, this guideline was limited to helicopters, but participants didn't want to begin with any restrictions on later discussions. As the workshop progressed, it became clear that most participants believed the LCS should handle aircraft up to the size of H-60 helicopters (both Army and Navy). There was divergence, however, about whether it should be a lily pad or capable of supporting a detachment. Those who favored the former capability did so with the understanding that being a lily pad meant more than simply landing helicopters for refueling.



Participants, although agreeing on this guideline, didn't vote on the issue of whether the ship should have a hangar. Most felt there were many good reasons for having a hangar — from facilitating reduced radar signatures to protecting aircraft from salt spray and corrosion during transits. Some felt that restricting the discussion to a topside hangar was inappropriate, believing the ship might be better using an elevator and mission deck to achieve the same ends.

Guideline 6. The ship should operate with optimized or reduced manning.

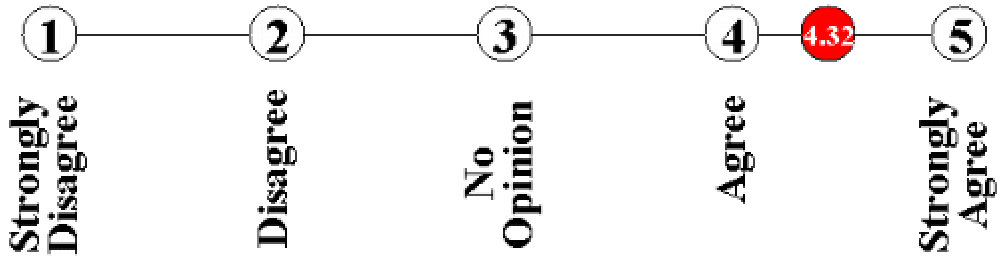
This guideline provoked sharp debate about the benefits and risks of reduced manning. Manpower costs are generally the largest lifecycle costs associated with ships. Thus, reducing manpower makes great sense. Nevertheless, reduced manpower generates new challenges, only some of which can be solved by automation. Again and again issues of peripheral duties (such as launching and recovering unmanned vehicles, hotel services, damage control, and boarding parties) as well as crew rest, mission fatigue, and endurance were raised. Those favoring reduced manning believed LCS must be highly automated, and that the core crew must be augmented by appropriate "mission crews," a concept we discuss later in this report. Those favoring an optimized/larger crew appreciated the flexibility and sustainability a larger crew brings.



Although reduced manning is one of the imperatives for the littoral combat ship, the vote reflects that participants remain sensitive to the risks associated with smaller crews.

Guideline 7. The ship should use open architecture and modularity.

Ships (such as aircraft carriers) and aircraft (such as the B-52) that have demonstrated extremely long, yet useful, service lives have taken advantage of open architecture (that is, they have remained useful because they have, with modest modification, remained capable of carrying modernized weapons systems). Service life (and perhaps) flexibility can also be improved using modular techniques. Participants agreed that open architecture is a goal worth pursuing. There was much more debate about the benefits of modularity. Strong support was expressed for modular ideas involving vertical launch systems, manned and unmanned vehicles, but much less support was offered for conex box (containerized) modular concepts because of cost, storage, maintenance, forward logistics and training challenges.

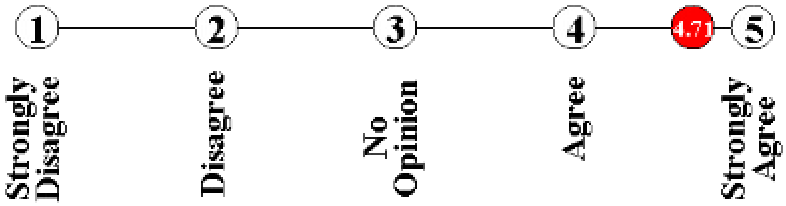


Because most participants agreed that open architecture was worth pursuing and that modularity could be achieved through manned and unmanned systems as well as weapons systems that can perform more than one mission (such as the vertical launch system), they showed strong approval for this guideline.

Guideline 8. The ship should be capable of launching, recovering, and operating manned, unmanned, and autonomous vehicles.

ASW, mine detection & clearance, and intelligence collection will increasingly depend on unmanned vehicles and offboard sensors. Both modularity and flexibility, as noted above, are enhanced with this capability. Originally this guideline addressed only unmanned systems. Special forces representatives reminded participants that they use some small manned vehicles (like jet skis and rigid hull inflatable boats) to support their

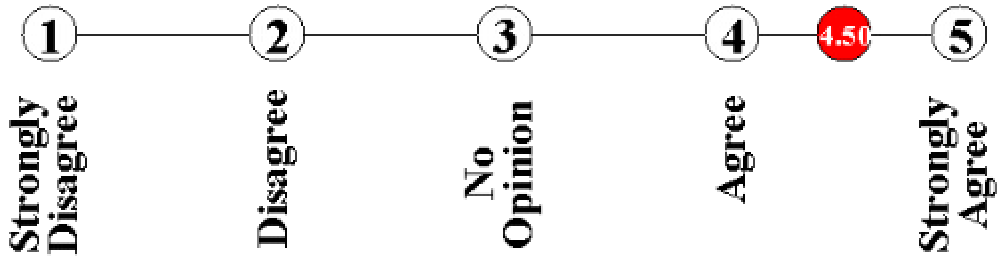
missions. A lot of participants believed unmanned vehicles would be the heart of the LCS system. Nevertheless, there was a big concern about when such vehicles would be ready for the fleet, leading to a discussion of a phased or evolutionary LCS design approach. They were also concerned how a drastically reduced crew would be able to launch and recover some of the unmanned vehicles that people are envisioning.



The vote shows the high degree of consensus achieved by participants on this subject. This was a strong endorsement for the Navy to move ahead as quickly as possible with unmanned vehicle programs that could be candidates for LCS.

Guideline 9. The ship should have core, organic self-defense capabilities.

This guideline was added during the first workshop. Participants agreed that you couldn't send a ship and its crew in harm's way and not provide them with some capability for self-defense. The level of this capability, however, was an issue. Most agreed that kinetic self-defense weapons are required while a few argued that stealth and speed should be its primary self-defense capabilities.



Strong support for this guideline was unsurprising, even though the value of speed and stealth as primary self-defense systems was debated. Those who favored kinetic systems pointed out that the LCS was being designed to operate in areas of high coastal traffic and anyone with good eyesight and a cell phone could counter the most expensive stealth designs available, while speed alone is of little help against a cruise missile. Mission area workshop participants were asked to consider weapons systems that could perform both mission and self-defense roles, thus achieving a synergism and affordability in line with the design philosophy.

FOR WHICH MISSION AREAS SHOULD THE LCS BE DESIGNED?

By the time participants were provided the opportunity to discuss mission areas, they had taken part in rich give-and-take discussions about the ship and the philosophy behind it.

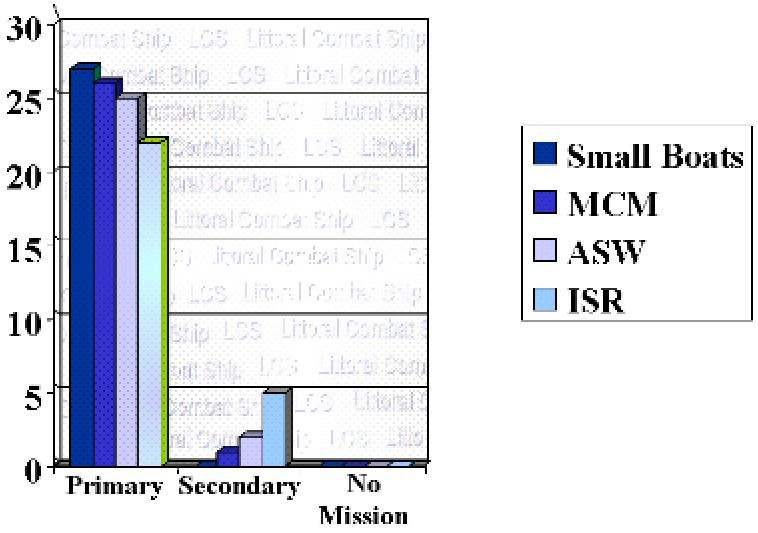
To stimulate mission area discussions, they were given a list of missions that had been proposed in news articles and concept briefings.

- Assured Access to the Littoral
  - Mine Warfare
  - Prosecution of Small Boats
  - Prosecution of Diesel Submarines
  - Prosecution of Air and Cruise Missiles
  - Deployment of Expeditionary Sensor Grid
- Support of Special Warfare
  - Local Fire Support/ASUW
  - Insertion/Extraction/Resupply of SOF
  - Information Operations
- Presence Operations
  - MIO, NEO, Exercises, Force Protection
- Homeland Defense
  - Dominant maritime awareness
  - Air and Sea interdiction

An in-depth discussion about each area (and others proposed by participants) resulted in the selection of four primary missions and two secondary missions.

Primary missions

As the following vote demonstrates, there was overwhelming agreement that prosecution of small boats, mine countermeasure warfare, littoral anti-submarine warfare, and intelligence, surveillance, & reconnaissance should be primary missions for the LCS.



There was strong consensus (90% agreement) that homeland defense (primarily the ability to conduct maritime interception operations) and special operations support should be secondary missions for the LCS. Nine other missions were considered, but garnered

too little support for further consideration. Those missions included: environmental data collection, logistics lily pad, anti-air and anti-cruise missile prosecution, unconventional warfare (working with indigenous special forces), counter-drug & law enforcement, area force protection, non-combatant evacuation operations, humanitarian assistance, and offensive mining. Some of these missions were rejected as too ambitious for the LCS (such as strike and naval surface fire support). Others were rejected because the LCS could assist in their execution (such as humanitarian assistance and NEO), but needn't have its design altered specifically to conduct them.

PRELIMINARY NARROWING OF LCS CHARACTERISTICS

As a result of the discussions surrounding approval of the guidelines and selection of mission areas, a preliminary narrowing of LCS characteristics was possible. These results were briefed to N76 following the initial workshop. The ship should be designed to support:

- Four primary missions identified (see above)
- Two secondary missions identified (see above)
- Maximum networking
- Open architecture
- Some modularity
- Optimized manning
- Battle group deployments
- Helicopter operations
- Some organic self-defense
- Unmanned and manned vehicles

These categories narrowed follow-on discussions, but much detail was left to be worked out during the mission area and integration workshops. For example, the decision that the LCS will be air capable doesn't answer the question about whether the ship will support lily pad or organic detachment operations. As noted earlier, three groups emerged during these discussions — one supporting a concept that relied almost entirely on offboard sensors and weapons we call "Type A," one supporting a much smaller ship we call "Type B," and the last supporting a larger ship we call "Type C." The following table shows the differences between the three concepts.

As the mission area workshops progressed, support for the Type C ship increased, but support for the other concepts never completely evaporated. One reason Type C gained increasing support was that it became more and more obvious that the size limitations of Type B would adversely affect mission accomplishment and logistics support, and that Type A was dependent on systems still unavailable if it was to move beyond logistics missions and accomplish war fighting missions such as ASW and MCM. Having said that, there was growing support for the idea that, to the extent possible, the LCS's capabilities should be contained in the vehicles it deploys, rather than in hardwired, organic systems. A concomitant benefit of this approach is that the vehicles developed for use by the LCS, and the mission payloads they carry, could be used from almost any platform — helping create, in effect, a modular fleet.

	Type A	Type B	Type C
Deployability	Deployable in support of the battle group	Deployable when accompanied by battle group	Deployable independent of battle group
Endurance	Range more important than endurance	Capable of short (<week) independent operations	Capable of lengthy (>month) independent operations
Helicopter ops	Supports lily pad/detachment ops	Supports lily pad operations	Supports helicopter detachment
Mission capability	Lift, support OOV mission	Single-mission	Multi-mission (sequentially)
UV operations	Complete reliance on unmanned vehicles	Controls unmanned vehicles	Supports & Operates unmanned vehicles
Logistics	Could be part of new logistics framework	New logistics framework required	Normal logistics support
Manning	Minimum manning	Reduced manning	Optimal manning
Concept of ops	Dashes in/out of littoral	Dashes in/out of littoral	Operates in littoral
Connectivity	Fully netted	Mission netted	Fully netted
Modularity	RO/RO modular	Mostly modular (single mission or module)	Highly modular (open architecture)
Stealth	Reduced signatures	Stealthy	Low signatures
Speed	High speed	Very high speed	High speed

Roles and missions.

As noted at the beginning of this report, March 2002 workshop participants decided that the Littoral Combat Ship should be designed for four primary missions (littoral ASW, intelligence preparation of the battlefield (ISR), MCM, and small boat prosecution) and two secondary missions (homeland defense/maritime intercept operations and special operations support). These missions coincided fairly well with SURFPAC's straw man proposal (Appendix B). The next portion of this report parses the SURFPAC message in order to compare and contrast it with our findings.

Littoral ASW.

> *"USV/UUV's emphasizing acoustic modular payloads such as side-scan and high-frequency active sonars to detect ... low doppler, near bottom subs in shallow, high ambient noise environment. UAV's emphasizing non-acoustic modular payloads such as multi-spectral/hyper-spectral camera, tactical synthetic aperture radar (TSAR), advanced radar periscope detection device (ARPDD), and EO/IR. On board weapons/self-defense systems might include a vertically-launched 'hedgehog' type of ASW rocket for quick reaction and mobile, acoustic decoys."* CNSP 010200Z MAR 02

Littoral ASW presents enormous challenges — beginning with trying to detect, locate, and track quiet, submerged diesel submarines in a high ambient noise environment. Shallow water challenges also face ASW weapons. No single system is envisioned for overcoming these challenges. ASW workshop participants identified and prioritized 23 tasks (see Appendix C) they believed the LCS should have the capability to conduct. They stressed the ability to deploy a variety of helicopter systems, hull-mounted or towed systems, and unmanned systems, and being able to exchange data with other battle group assets. They were split about whether the LCS should support an organic helicopter or simply serve as a lily pad for helicopter operations. Just over half indicated the LCS should have either one or two aircraft on board and just under half indicated it should serve as a lily pad.

Since one purpose of the LCS during conflict will be to punch a hole in adversary defenses permitting the introduction of follow-on forces, it will be a prime target during the initial stages of fighting. Participants therefore insisted the ship needs a surface ship torpedo defense (SSTD). Speed (40 to 50 knots) was also often mentioned as desirable for torpedo evasion and prosecution repositioning. Participants recognized that speedy operations might pump a lot of sound into the water, but didn't see this as inconsistent with the requirement for acoustic signature reduction because the times that speed would be needed are when the submarine is already aware of the ship's presence. Speed could also prove useful in positioning the ship far enough ahead of the force to conduct ASW prosecution effectively before remaining battle group assets arrive. They also asserted that the ship requires an onboard, standoff offensive ASW weapon.

Some participants argued that the LCS should be used to lay a broad area sensor grid that is exploited by others to prosecute submarines. Speed might prove useful in laying such a grid. As in other areas, however, many of the sensors and unmanned systems envisioned are currently unavailable requiring at least the first flight of ships to use currently available systems. A real ship needs real capabilities. If unmanned off-board sensor systems eventually become the centerpieces of LCS capabilities, connectivity and bandwidth become very important issues.

Participants believed that ASW will remain an art form that will require more attention and training than an "optimally" manned crew can provide. For that reason, they believed that the crew would have to be augmented with approximately ten ASW experts when that mission was anticipated. They recommended that the core crew be trained in the launch and recovery of manned and unmanned systems supporting this mission, but the actual systems would be operated by the ASW detachment. Ideally, these systems will use the same handling equipment and techniques as systems used in other mission areas.

Intelligence preparation of the battlefield.

> *"In order to enhance the capability to collect, process, and disseminate information and conduct OTH ISRT missions, LCS concept development should consider the CNO strategic studies group (SSG) ForceNet concept. ForceNet is defined as 'the architecture and building blocks of sensors,*

networks, decision aids, weapons, warriors, and supporting systems integrated into a highly adaptive, human-centric, comprehensive system that operates from seabed to space, from sea to land.' It envisions a seabed-to-space, multi-tiered sensor grid, integrated information systems, information converted to actionable knowledge, and distributed combat capability (both manned and unmanned) to enable a fully prepared and informed warrior. The naval fires network (NFN) and other potential systems should be explored for ability to provide time critical targeting and info superiority. Data fusion technologies that enhance decision making and combat action in a reduced manning environment are essential to making LCS a viable platform in a future of reduced financial resources. LCS must be able to leverage all available information without requiring an inordinate number of organic sensors and with minimal/optimum manning." CNSP 010200Z MAR 02

Calling the LCS a "node" has become fashionable in the network centric warfare era. Many participants pointed out, however, that ideas like FORCEnet are concepts not capabilities. Participants in this ISR workshop and other mission area workshops provided a number of *real* connections they believed the LCS should have. As one participant wrote, this means "bandwidth, bandwidth, bandwidth." SURFPAC was wise in pointing out that data fusion technologies are the glue that makes network centric warfare work, especially when crews are small. They will be physically unable to monitor all the circuits with which people envision the LCS being connected. When the mission requires the collection of compartmentalized data, the LCS may have to support cryptology detachments. Because the littoral is a crowded and noisy environment, a good operational picture is the bedrock requirement for successfully operating there. Some participants believed that this awareness would come through the deployment and monitoring of an extensive sensor grid (which doesn't currently exist). Others believed awareness would be generated as the result of onboard sensors, sensors employed by organic manned and unmanned systems, and from sensors deployed by others.

ISR workshop participants identified and prioritized 29 tasks (see Appendix C) they believed the LCS could be called on to conduct. Like participants in other mission area workshops, they bet on future development, and gave their highest priority to launching, recovering and supporting unmanned systems that do not yet exist. They also stressed automated data fusion along the lines suggested by SURFPAC along with the use of artificial intelligence systems. They also stressed connectivity.

The problem is larger, of course, than simply connecting to US military systems. It is anticipated that the LCS will serve as one of the principal assets involved when conducting coalition operations, which means it must be interoperable with friends and allies. It will also conduct maritime interception operations, which means it much be able to communicate with merchant shipping. When it conducts MIO operations in defense of the homeland, it must be able to coordinate with the Coast Guard and other government agencies and departments. Emission control is likely to be an issue for the LCS since even with all of this connectivity, the ship must be able to operate as clandestinely as

possible. Participants believed that open architecture and digital electronics were key to meeting all these challenges.

Participants went beyond technology sensors and stressed the importance of supporting human intelligence in the form of special operating forces. Like participants at other workshops, participants of this workshop were split concerning the need for a helicopter detachment vice providing the LCS with only lily pad capabilities. Since participants believed that a ship involved in data collection and dissemination must be in the environment for long periods, they put much less stress on speed than other mission areas and stressed instead the endurance required by the ship.

Mine countermeasures.

> *"USV/UUV's emphasizing acoustic modular payloads such as side-scan and high-frequency active sonars to detect mines ... in shallow, high ambient noise environment."* CNSP 010200Z MAR 02

Participants at the MCM workshop did not envision the LCS itself as a mine hunting or mine sweeping vessel per se. High among the 28 tasks they identified in this mission area (see Appendix C) were launching, recovering, and supporting a variety of manned and unmanned systems that would perform the actual mission. More work has been done on unmanned and autonomous systems in the MCM area than in any other. The Remote Minehunting System (RMS) offers an excellent example of the type of unmanned system that should be incorporated on the LCS. If the sonars used by RMS can be adapted for use in shallow water ASW, the Navy will make a big leap towards its goal of relying more on unmanned systems for future missions. Participants believed that unmanned systems should go beyond current systems by incorporating identification and destruction systems in unmanned systems. Until that capability exists, the LCS will need to be capable of hosting a 10-person EOD/SOF detachment along with its equipment. Much like ASW, MCM is an art form and the ship would probably also require a crew enhancement when this mission was contemplated. The primary responsibility of the core LCS crew would be supporting these teams and their equipment.

The manned systems most often mentioned were helicopters. Unfortunately, the size of the sleds pulled by MH-53 helicopters are too large for H-60s and no one believed the LCS should be capable of landing the MH-53 on board. As a result, participants were split between those who believed the LCS should be a lily pad and those who believed it needed to support up to two organic helicopters.

MCM remains a time intensive endeavor, which means that MCM assets have to be in the risk area well ahead of the main force in order to locate mines so they can be avoided or, if necessary, destroyed. The requirement is not to clear all mines, but to punch a hole big enough in adversary defenses to permit access by follow-on forces. Although participants indicated that the LCS must have sufficient speed to arrive ahead of the force, the fact of the matter is that MCM assets must deploy so far in advance of the main force that speed is only a secondary consideration. In order for the LCS to operate in as many potentially

mined areas of interest as possible, ship draft is an important consideration as is magnetic signature reduction.

Small boat prosecution

> *"UAV/USV's with various modular payloads such as electro-optical/ infrared (EO/IR) to provide real-time or near real-time imagery; laser target designator/range finder capable of supporting weapons launch; and a tactical weapon (e.g., Hellfire-like weapon). These payloads will enable detection, ID, tracking, and engagement of surface threats prior to their weapons release range. On board weapons might include next-generation stabilized chain guns, small arms, and future directed or pulsed energy weapons."* CNSP 010200Z MAR 02

This mission requires many of the same capabilities as maritime interception operations with the major differences being that small boat prosecution requires even better sensing and much more capable offensive weapons. Threat detection is a critical challenge. Small boats are hard to detect beyond their effective weapons range and, even if detected, distinguishing between hostiles and non-hostiles can be difficult. For this reason, participants stressed the importance of a multi-function radar and electro-optical and infrared systems as well as off-board sensors. While there is a tendency to view small craft as very short-range threats, some patrol boats are capable of launching attacks beyond the horizon. Relying on short-range guns will not be sufficient for dealing with this issue. In addition to small and medium caliber guns, it is essential that LCS be equipped with weapons capable of providing significant punch at over the horizon ranges. Another challenge when prosecuting small boats is the sheer size of the attack that can be launched. A single ship can be overwhelmed and the chances of disabling or destroying all incoming threats beyond their weapons range rapidly diminishes as the size of the attack increases. Participants' organic weapons of choice were a rapid firing, small and medium caliber gun and anti-ship missiles. Because participants had a healthy skepticism that onboard systems were the total answer, they strongly advocated having an armed, organic helicopter or UAV on board to complement onboard weapons systems and provide "defense in depth" when operating in a high risk environment.

This is one mission area where speed and maneuverability play important offensive and defensive roles. In fact, participants made speed and maneuverability their highest priority along with long-range detection of small boats and the ability to prosecute them with unmanned vehicles. Participants believed that prosecuting small boats was one mission area that the ship must be able to conduct all the time. Although prosecuting small boats could be "the" assigned mission of the LCS, a more likely possibility is that it would have to prosecute them while conducting other missions. When appropriate unmanned vehicles are developed for this mission area, detecting, localizing and destroying threats at appropriate distances should become easier.

Special operations

Special operations personnel would like the Navy to provide them with hulls that they can outfit themselves as dedicated special operations vessels. Barring that possibility, they made their highest priority a robust, secure C4ISR capability (including SOF dedicated spaces and communications when special forces are on board). That was closely followed by the requirement to launch and recover SOF craft in 4 to 6 foot seas and 18-20 knots of wind. Finally, they would like to have berthing and hotel support for 32- to 45-man detachments, with the ability to support up to 100 personnel for short periods. This implies the ship must be capable of handling all of their equipment as well. At a minimum, the LCS should be capable of handling two RHIBs.

As expected, SOF workshop participants also stressed the importance of speed and stealth (especially reduced RCS, IR, and visual profile) for their missions. They would also like the ship to have a draft as shallow as 9 feet, so that it could take them as close to shore as possible for insertion (although in the integration workshop they backed off somewhat from the 9-foot draft requirement). This mission area was the only one where participants expressed a desire to have long-range weapons in order to provide cover (overwatch) for insertion and extraction. Since they believed the ship must fight toe-to-toe with adversaries, they recommended the ship be both heavily armed and armored (even though it was pointed out that armor and speed isn't a cheap combination). Part of the firepower could be provided by armed helicopters (2 preferred), which could be provided either by the Navy or Army.

Homeland defense/maritime intercept operations

One of the recurring arguments for small ships is that the Navy has been required to use expensive, large ships to conduct intercept operations that are better conducted by smaller vessels. Because intercept operations are generally conducted by single ships, participants insisted that the LCS must have organic weapon systems so that it can conduct this mission "alone and unafraid." As noted earlier, intercept operations pose a stressing communications environment, and participants made "secure, interoperable communications" with all necessary MIO elements their highest priority. Closely behind was the ability to maintain a single, integrated common operating picture. Even though vessels of interest are generally commercial vessels, finding the target vessel among a myriad of other vessels is a difficult challenge. When vessels of interest are smaller, high speed boats, the LCS must have the sprint capability necessary to reposition for intercept. On the other hand, MIO is often a waiting game and the ship must be able to loiter in areas of interest for extended periods.

Participants also noted that any ship engaged in intercept operations must be ready to operate without (or provide for the absence of) crew members tasked as steaming or prize teams. Since some boardings are non-cooperative, the ship must also be ready provide berthing and hotel services for boarding teams and be able to support their equipment (RHIBs and helicopters). Plans for berthing and providing hotel services for up to 32 people is a reasonable requirement and in line with SOF requirements mentioned above.

Since MIO seldom involves the use of deadly force, participants recommended fielding non-lethal technologies for disabling or holding a non-cooperative vessel at risk. They also stressed investment in sensors that can assist in standoff searches and real-time television monitoring of boarding parties. Participants also recommended investing in unmanned systems that could be used for search and support.

Integration workshop

In June 2002, a final integration workshop was conducted at the Naval War College in Newport, RI. A briefing drawn from the interim report was used as the straw man for discussion. Since most of the participants at the integration workshop had attended one or more of the other workshops, we wanted them to validate, or modify our portrayal of the findings from those workshops. We began by having them comment on the "bullets" we created for each workshop with an eye towards telling us what we missed. For the most part, participants indicated that we had captured the most important issues. A copy of unedited comments was provided to the sponsor following the workshop. Participants were then asked to comment on the "maneuvering board" characteristics described below. They were given the opportunity to indicate a "threshold" and an "objective" level for each characteristic. Since all characteristics are not of equal value, participants were asked to compare characteristics head-to-head in a pairwise comparison exercise as well as weight the characteristics using an allocation exercise. Our desire was to ensure internal consistency and to provide a prioritized list of characteristics for ship designers. We also wanted to compare their preferences against the guidelines the working group had established at the beginning of the process to determine how true they were to the process.

The second day of the workshop examined the three LCS variants that emerged from the mission area workshops. Participants were asked for their preferred variant and their preferred course of action (pursuing one, two, or all three variants). As noted in the introduction, nearly 60 percent of the participants would first pursue a Type C variant, while Types A and B were favored by approximately 20 percent of participants as their first choice. In addition, they voted to recommend pursuing two variants vice three (dropping Type A for the reasons noted in the introduction). The results of the integration workshop voting will be interspersed in the following discussion of consolidated characteristics.

CONSOLIDATED LCS CHARACTERISTICS

One of the reasons we included the COMNAVSURFPAC (CNSP) message in Appendix B is that the straw man ship it proposes, although not shared with participants at any but the first workshop, turned out to capture much of what was proposed during the six mission area workshops. In the following section we examine the consolidated characteristics of the LCS, and we will once again parse the SURFPAC message and compare it to workshop results. (For more detail on workshop results, see Appendices C and D.)

Broad concept.

> *"LCS is envisioned to be a fast, agile, stealthy, relatively small and affordable surface combatant. Its warfighting capabilities should be optimized for versatility in the littorals for anti-access and 'gapfiller' missions against asymmetric threats. A defining characteristic should be extensive reliance on a variety of organic unmanned vehicles. The ship should leverage transformational weapons, sensors, data fusion, C4ISR, materials, hull design, propulsion, 'smart' control systems, optimal manning concepts, and self-defense systems to enable it to survive and thrive in an adverse littoral environment."* CNSP 010200Z MAR 02

This general description remains fairly accurate of either a Type B or C LCS variant. The big difference is in how participants and SURFPAC define "relatively small." We agree with the SURFPAC message that the ship's capabilities should determine its size, and we would add that externally imposed size "restrictions" should be avoided. The accelerated schedule on which the LCS has been placed may limit incorporation of some transformational systems because many, like most unmanned vehicles, are not ready for operational use. One undeniable fact is that the ship must be able to utilize current systems as surrogates for those not yet available if it is going to be useful as a warship (vice a logistics ship) in the near term. We are also struck by the fact that the LCS has been given missions (like mine countermeasures and littoral antisubmarine warfare) that the Navy has historically had difficulty performing. These missions have not become easier. Mine hunting and sweeping remains a slow, tedious process whether conducted by autonomous systems or manned mine hunters and sweepers. There are some synergies, however. Systems used for locating mines might also be used for finding quiet submarines in the same littoral waters. This was a course strongly recommended during the integration workshop.

There are still differences of opinion concerning the operational concept that should be used by the LCS. Some contend that the LCS should be a fast, maneuverable delivery vehicle whose primary function is to employ off-board sensors and autonomous unmanned vehicles in the littoral, withdraw to a safe distance, and then rush in to recover them when their mission is complete (i.e., the Type A LCS). NWDC has published a "business plan" casting its experimental High Speed Vessel as a model that LCS could build upon, one that would rely on overseas bases from which an LCS squadron would

operate and where LCS would retire to change out modular mission packages. Others see the LCS as a ship that may have to engage in small skirmishes while in the littoral, such as when extracting special forces personnel. They would like to see a ship that is relatively more heavily armed, faster and more stealthy than proponents of Type A. They also believe the ship must be relatively small and highly maneuverable (i.e., the Type B LCS). Finally, some see the LCS as a ship that must freely operate in the littoral, and from the beginning be as capable as possible of punching a hole in adversary defenses in order to enable the introduction of other forces into the area (i.e., Type C LCS).

Beyond these general ideas, we did not dwell on operational concepts. The LCS characteristics discussed in the remainder of this paper, if adopted, should make the ship adaptable to many current and future (yet to be defined) employment concepts. We begin by discussing individual characteristics and will close with more focused mission area characteristics.

Manning deserves a special mention. Much of the press that has been generated concerning the LCS has focused on the fact that it will have a small crew. As noted earlier, workshop participants expressed concerns about sailing a ship tasked with important and difficult military missions that need to be conducted in areas of high risk using dramatically reduced crews. In fact, every mission area workshop, by a wide margin, insisted that the ship requires crew augmentation in order to carry out specific missions. When participants at the integration workshop were asked if they agreed with this assessment, they unanimously agreed or strongly agreed. This fact has enormous consequences, not only for designing berthing and hotel services aboard the ship but for personnel policies, training curricula, and logistic support as well.

Speed and agility.

> *"In order to survive and accomplish its missions, LCS must be considerably faster and more agile than current surface combatants. The speed and agility of LCS will be critical for efficient and effective conduct of the littoral missions envisioned. ... Further, the survivability of LCS will depend in part on its speed, maneuverability, and stealthy design. However, LCS does not necessarily have to be capable of sustaining its top speed for extended periods. It may be sufficient that it be able to cruise at 30 knots and sprint at 50 knots — possibly to avoid a small boat or sub threat, intercept a potential terrorist smuggling vessel over the horizon, or retire from a SOF extraction mission. The requirement for speed may necessitate tradeoffs in size and weight of permanently installed weapons systems."* CNSP 010200Z MAR 02

Fifty knots sprint seems to have become a line in the sand for the LCS — one that may prove so costly that it will adversely affect other LCS characteristics. SURFPAC points out that the desire for speed must be weighed against other tradeoffs. We strongly agree. Nobody expressed a requirement for LCS to run around at high speed all the time. The comment that "it may be sufficient that [the LCS] be able to cruise at 30 knots and sprint

at 50 knots" falls very much in line with participants at our workshops. Our sense of the workshops is that the LCS must be able to deploy with battle groups and have a sprint capability of between 40-50 knots in order to carry out specific missions. In fact, nearly two-thirds of all comments concerning speed indicated this was the proper top-end range. When we asked participants at the integration workshop if they agreed with this assessment, nearly 60 percent agreed.

We asked in two different ways about the importance of speed compared to other LCS characteristics. When asked to allocate a fixed amount among the characteristics, participants rated LCS connectivity twice as important as speed. They also rated the operation of offboard sensors nearly twice as important as speed. Organic sensors and weapons were also rated higher than speed. In head-to-head comparisons between characteristics, speed only ranked higher than endurance and range.

The two mission areas during which participants indicated top end speed was not important were the Mine Countermeasures and Intelligence Preparation of the Battlefield (ISR) workshops. They believed the LCS only needed sufficient speed to reach the operating area ahead of the battle group. Once on station, speed didn't matter. SURFPAC talks about the possibility of using "electric drive," but preliminary indications are that state-of-the-art electric systems that could fit in the LCS are not capable of generating the required speeds. Most participants favored a dual propulsion system — one for cruise (a diesel) and the other for sprint (a gas turbine).

We also asked mission area participants about range and endurance. The majority of participants believed the LCS needed to be capable of deploying with a battle or surface action group and steam unrefueled between the East Coast and the Mediterranean (or the West Coast and Hawaii). We set that distance at a nominal 4000 nautical miles. Endurance responses reverted back to the differences noted in the initial workshop. Those favoring a small, Type B ship believed LCS needed to be able to operate independently for a week or less. The vast majority of participants, however, believed it needed to be able to operate independently for a month or longer. During the integration workshop, range and endurance were clearly the areas where participants believed trade-offs should be made. When asked to weight characteristics, range and endurance fell out on the bottom. In head-to-head comparisons, range beat endurance and endurance was never selected as being more important than any other characteristic. This finding is consistent with Baseline/Flight 0 guidelines found in Appendix A.

Unmanned vehicles.

> *"Because size, speed, topside weight, fuel, and affordability considerations will limit ship-launched weapons and sensors, LCS is envisioned to make extensive use of a variety of organic unmanned aerial vehicles (UAV's), unmanned surface vehicles (USV's), and unmanned underwater vehicles (UUV's). An organic system of UV's, fully netted to the ship, brings many advantages to the table. UV's would serve as battlespace extenders, allowing LCS to conduct missions over the horizon*

> *and support the war ashore. They are force multipliers that will allow a single ship to conduct a variety of missions with limited outside support. LCS should provide inherent modular-mission capability through easily interchangeable UV payloads. The missions a system of organic UV's will enable or enhance include intel, recon, surveillance, and targeting (ISRT), OTH SUW, MCM, sigint, comm relay, chem/bio recon, EW, and combat SAR, to name only a few."* CNSP 010200Z MAR 02

Participants at all workshops agreed that, when available, unmanned vehicles should be extensively used by the LCS. They also agreed that LCS modularity should primarily be contained in "interchangeable UV payloads." Since few of these systems are available, we asked participants at the integration workshop to consider RHIBs and helicopters as surrogates for offboard organic vehicles (OOVs) in their votes. Only networking was ranked as more important than operating OOVs when asked to weight the characteristics. In head-to-head competition, operating RHIBs/USVs and helicopters/UAVs each won 8 of the 9 comparisons in which they were matched. In the comparison against each other, helicopters/UAVs beat RHIBs/USVs 56 to 44 percent. Clearly the Navy must make the development of OOVs a priority if this vision for the LCS is to be realized.

This begs the question of how these systems should be launched and recovered. There is good news and bad news in this area. The bad news is that there are not very many unmanned systems ready for service on the LCS. That's also the good news, since it means that the Navy can insist that developed systems use common, automated launch and recovery systems (one for sea and another for air vehicles) and common command and control systems. Many participants believed that a stern ramp was an affordable, efficient method for launch and recovery of USVs (as well as manned RHIBs). The fewer personnel required to perform the operations the better, with full automation the goal. Since much of LCS's mission capability will eventually be contained in unmanned systems, they must also be extremely reliable and day/night all weather systems. If speed really is an important survivability factor for the LCS, then speed of launch and recovery is also critical. Ideally, systems would be able to be launched quickly while the ship is operating at high speeds. Since unmanned systems are unlikely to form the initial combat capability of the LCS, if real war fighting capability is to be achieved in the near term, current manned systems must be accommodated at least for initial LCS flights.

Air capability.

> *"A flight deck for operating, fueling, and supporting UAV's is essential. LCS is not envisioned to maintain a full air detachment (i.e., SH-60 det) with the space/material impact and maintenance support manning that entails, but must retain the ability to support helicopter operations such as refueling, lillypad, and vertrep."* CNSP 010200Z MAR 02

Mission area workshop participants clearly departed from this "no det" vision of LCS. Helicopters proved important for almost every mission area. In head-to-head characteristic comparisons, operating helicopters/UAVs lost out only to being networked

as the most important characteristic for the LCS to have. A large majority of participants believed that the LCS should operate and support at least one helicopter (meaning an organic assset). Seventy percent of participants at the integration workshop either agreed or strongly agreed that the LCS should have an organic helicopter, at least until UAVs become available. That means that the LCS must have a hangar. Participants recommended that the LCS be capable of operating Army as well as Navy helicopters (their size is the same but their wheel bases are different). If (when?) helicopters are replaced by UAVs, the facilities used by helicopters should be readily adaptable for unmanned vehicles. A hangar was also considered important in order to maintain a low radar cross section when aircraft are aboard.

RHIB and USV capability.

> *"Ship configuration should allow for smooth launching and recovery of a variety of UUV's, USV's, rescue boats, and SOF craft without the need for davits that are cumbersome, add topside weight, and increase radar cross-section. The most likely solution is through a stern ramp or gate but may also include a variable depth capability for LCS."* CNSP 010200Z MAR 02

Participants at all workshops agreed that smooth launching and recovery of unmanned and manned systems was critical. As noted above, connectivity was the only characteristic deemed more important for the LCS than the ability to launch and recover offboard organic vehicles. None of our workshops discussed "variable depth capability" for launch and recovery, favoring the "stern ramp" approach for as many seaborne systems as possible. Many of the mission areas could use either manned RHIBs or unmanned USVs (like Spartan) to help them execute their tasks.

Participants at the integration workshop were asked to consider RHIBs as surrogates for USVs. They were also briefed on mission area workshop results that indicated two 11-meter RHIBs were the minimum required for several mission areas. When asked if they agreed, 73 percent voted in the affirmative. This means that the LCS must be capable of adequately supporting their associated personnel as well. Augment teams of up to 15 individuals per boat should be planned for.

Self-defense systems.

> *"On board hard kill/active systems might include fixed vertically-launched air defense weapons as well as man portable missiles (e.g., stinger-like) for air and small boat defense. On board soft kill/passive systems could include both active and passive decoys, ECM with potential for dynamic signature control, and towed acoustic decoys (e.g., nixie-like device)."* CNSP 010200Z MAR 02

Workshop participants agreed that the ship should come equipped with missiles, but more often expressed a preference for something like the Rolling Airframe Missile (RAM) than

they did for man portable missiles. We agree with SURFPAC that a vertically launched system provides more flexibility for both offense and defense than does a purely defensive missile. Even more often than missiles, however, participants mentioned small and medium caliber rapid-fire guns. However, these weapons alone do not have the range and punch required to deal with much of the threat encountered in the littoral. Participants also agreed that a full range of decoys and torpedo defense systems are important for the ship's survivability. When integration workshop participants were asked about the range of self-defense weapons, 84 percent of them agreed that it should possess local area weapons (i.e., weapons with more than a point defense capability).

Although the data clearly demonstrates that participants from the workshops were strongly committed to organic offboard vehicles, they also felt that the LCS would be asked to fight in one of the most complex and dangerous environments in the world and a total reliance on OOVs for self-defense was unwise. As a result, organic weapons were rated fourth among characteristics the LCS should have and organic sensors close behind at sixth. In the head-to-comparisons, the order of sensors and weapons reversed, but they remained fourth and fifth in the voting. This is an area they clearly do not want shortchanged.

On board sensors.

> *"On board systems would likely include ESM, surface search radar, periscope detection, CBR detection (e.g., CAPDS, AN/KAS-1, M31E1 biological integrated detection system (BIDS)), mast mounted sights (e.g., FLIR, night vision, electro-optical, laser range finder), and 2-D air search radar. Other possibilities: small scale 3-D air search radar, towed array, towed active sonar."* CNSP 010200Z MAR 02

As noted in the paragraph above, integration workshop participants believed that the LCS must have some onboard sensors in order to defend itself. In the mission area workshops, radars were the most oft mentioned required on board sensor. Because of the number of missions assigned to the LCS, a small, multifunction radar would seem ideal. Next to radars, electro-optical/infrared systems were the most often mentioned, followed by sonar and ESM. Seventy-three percent of integration workshop participants agreed that sensor range needed to match weapons range, namely, local area sensors (which they interpreted to mean sensors with ranges beyond point defense range).

Participants proposed some unique employment schemes for some sensors, such as positioning UUVs within the hull so that its sensors could be deployed even when stowed.

Hull configuration.

Identifying preferred hull forms was beyond the charter we were given. A discussion of the benefits and drawbacks of various hull forms can be found in the companion to this study entitled, *Littoral Combat Ship (LCS) Technology Opportunities*. In this section we

discuss some of the proposed ship characteristics that did emerge during workshop discussions.

Stealth.

> *"Stealth will complicate the enemy's ISR and targeting solutions, enhance survivability, and facilitate certain missions such as SOF insertion and extraction. Topside design should provide a small radar cross-section through use of composite materials and a multi-spectral stealthy configuration. In addition, design should allow for mission stealth capability such as an enclosed 'moon pool' capability for SOF insertion operations."* CNSP 010200Z MAR 02

There were a lot of discussions about the value of stealth when operating in a high traffic, littoral environment. If LCS is primarily a night fighter (the preferred mode for SOF), then topside stealth probably makes a lot of sense. If, however, we don't cede the day to the adversary, then participants questioned the benefit of stealth versus its cost. Nevertheless, participants believed that reducing the ship's radar cross section should be a design objective. Since any fisherman in a dhow with a cell telephone can easily counter sophisticated signature reduction efforts, lowering the visual signature of the LCS is also important and the second most often mentioned signature concern. Magnetic, acoustic, infrared, and radio frequency signature reductions were also mentioned often. As expected, which signature was stressed depended upon which workshop was concerned. The MCM workshop stressed magnetic and acoustic signature reduction, while the ASW workshop overwhelmingly stressed acoustic signature reduction. Recognizing this, we divided signatures concerns into above water and below for the integration workshop. Added together, signature concerns would have placed fourth, behind connectivity and operating airborne and seaborne OOVs. Above water signature concerns placed slightly higher than below water signature concerns. For head-to-head comparisons, signatures were lumped together and were selected in two out of every three comparisons they were in. That said, we would agree with the Appendix A list that this is one area where trade-offs should be made.

Draft.

> *"The draft must be relatively shallow (20 feet or less) in order to facilitate shallow-water and near-land excursions."* CNSP 010200Z MAR 02

Participants agreed that a draft of 20 or less is desired for LCS. This will permit the ship to conduct mine countermeasure and maritime intercept operations in waters currently denied to deeper draft vessels. SOF workshop participants desired a 9-foot draft, although their representatives backed off of this requirement during the integration workshop.

At sea replenishment.

> *"In addition to vertrep capability inherent in the inclusion of a flight deck, LCS will require an at-sea fueling capability. This would provide for*

> *interoperability with legacy platforms as well as enable operations with allied navies. Also, since all future combatants will operate with reduced manning, LCS should capitalize on automated and modular unrep technologies for all at-sea and inport commodity handling."* CNSP 010200Z MAR 02

We disagreed with the Appendix A recommendation that the Baseline 0 LCS "transit without payload, at most economical speed, not in company with battle group." Workshop participants believed that the LCS must be capable of steaming with the fleet — which means it must be able to resupply in the same way as other battle group assets.

Because it will be smaller than other ships, its magazines risk being emptied more quickly; hence, the LCS requires an at-sea reload capability. Again, workshop participants didn't agree with the Appendix A recommendation that the Baseline 0 LCS should transit without payload, believing that such a sustainment paradigm would place an extra burden on the logistics force during peacetime and become unworkable during conflict.

Participants agreed with SURFPAC that automation in this and every other possible area is essential for helping keep down the size of the LCS crew.

Propulsion and engineering systems.

> *"Propulsion systems must provide a high speed capability. However, in recognition of fuel, size, endurance, and engineering tradeoffs, speed does not necessarily have to be sustained for long periods. It may be sufficient for LCS to only have a high-speed dash capability. Transformational propulsion and engineering systems, such as electric drive, should be explored not only to produce high speeds but to take into account optimal manning concepts such as propulsion, electric plant, and damage control automation and monitoring systems to support a minimum maintenance requirement."* CNSP 010200Z MAR 02

As mentioned earlier, it doesn't appear that electric drives of sufficient power densities will develop in time for inclusion in initial flights of the LCS; hence, the preference for a dual propulsion system (one for cruise and one for sprint). Automated engineering systems are essential in order to reduce crew size and workload. As little at sea maintenance as possible should have to be conducted on the LCS. This is particularly important if the Navy adopts innovative crew strategies, such as Sea Swap, which requires ships to remain on station for significant periods.[1]

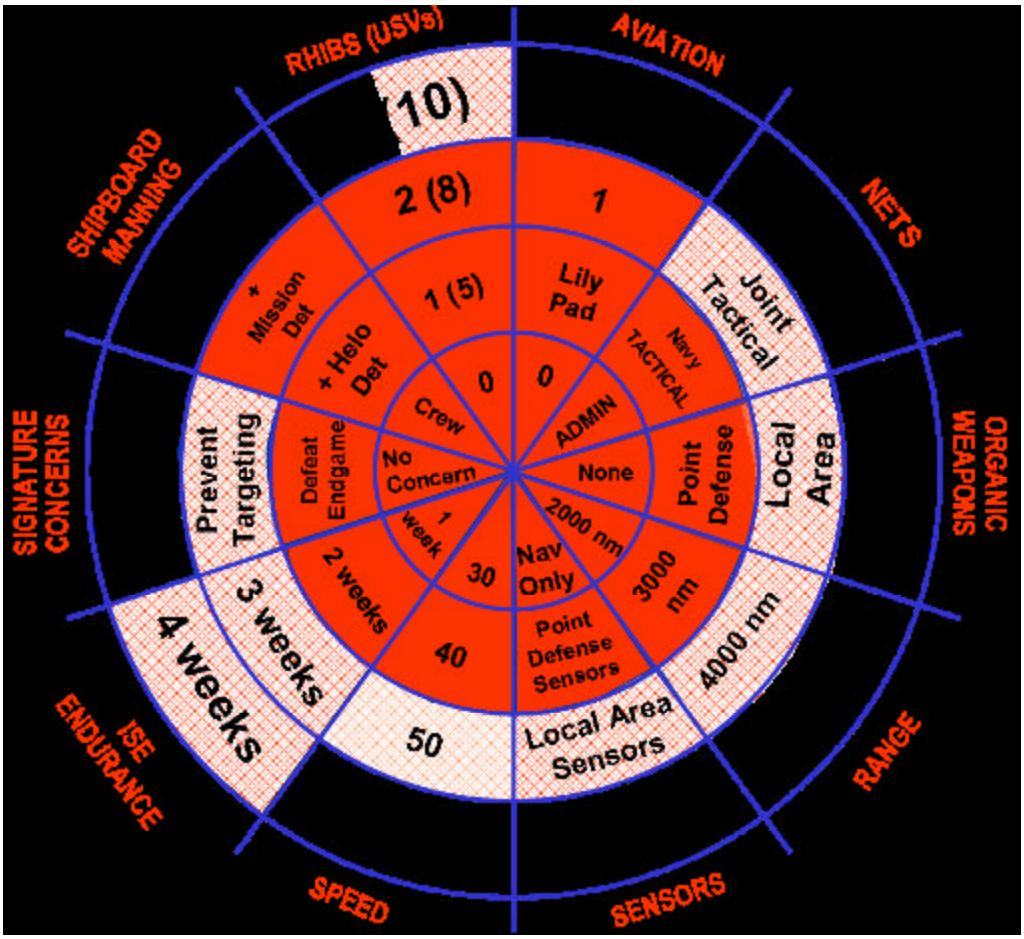
CONCLUSIONS

[1] Sea Swap was developed as part of the VCNO's Task Force Sierra work. Experiments being conducted under that name by COMNAVSURFPAC should not be confused with Task Force Sierra recommendations.

The Naval War College was tasked to provide N76 with "characteristics" for the Littoral Combat Ship. We took this to mean that we were to provide the broad outlines within which those tasked to come up with requirements and ship designs were to operate. In pursuing this objective we attempted to obtain the views of subject matter experts from both the fleet and technical fields. The data collected (mostly in the form of written opinions) filled over 500 unedited pages that were provided to the sponsor and program manager. This overview draws on the highlights of that data. Despite the myriad of opinions about the LCS (some of them strongly held), we tried to get an honest assessment of the desires and requirements of the fleet in putting our recommendations together. We understand there are tradeoffs to be made as the process goes forward. We hope this report helps those who must make these tradeoffs understand some of the consequences involved.

The following "maneuvering board" chart encapsulates our effort to integrate the data we collected. We like the maneuvering board analogy because it shows where the maneuvering room is located as requirements are firmed and cost/benefit analyses are completed. As the chart shows, we tried to avoid specific systems in favor of increasing "levels" of complexity and cost. This chart was presented to the integration workshop to see if we had accurately captured the inputs from the other workshops. Even though we changed it to satisfy some of their concerns, individual characteristic sectors were approved with an average 71 percent approval rating (the range was from 51 to 94 percent).

In order to ensure we filled in the maneuvering board correctly (that is, that we captured inputs from each of the mission area workshops), we had integration workshop participants provide us with threshold (minimum) and objective (desired) targets in each of the characteristic areas. That data is reported below.



In explaining the above maneuvering board chart, we will start at shipboard manning and move counter-clockwise. We explained to participants at the integration workshop that they should consider the rings cumulative as they proceed outward. This is indicated by the solid red coloring of the maneuvering board "cells." The cross-hatched, lighter red coloring of some outer cells indicates that the results fall some where in between the adjacent cells. Details are provided in the following sections. For example, we assumed that if they voted for mission detachment crewing for the ship, that they were also voting for the core crew and the helicopter detachment crew (based on the fact that they had also recommended the LCS have an organic helicopter).

Shipboard manning

Every mission area workshop concluded that the "optimized" core crew of the LCS would be insufficient to carry out the mission and nearly two-thirds of all participants believed the ship should support a helicopter detachment. Hence, the colored red portion of the chart shows that the ship should be designed to provide berthing and hotel services for the core crew, the helo detachment crew, and the augment or mission detachment crews of up to 32 people. There was a 94 percent agreement that the LCS would have to have its crew augmented depending on the mission with which it was tasked. Hence, designs should take this threshold requirement into account. Their objective target was

more bifurcated, with 47 percent recommending mission detachments as the objective and 44 percent recommending a fully capable completely manned crew (i.e., no helicopter or mission detachments needed) as the objective. This vote reflected a belief that for many tasks an optimized crew would find itself undermanned, even with augmentation.

Signature concerns

The range of signature concerns put forward in the mission area workshops ranged from "no concern" by some participants in the MIO workshop to "preventing detection" in the special operations workshop. Stealth, however, is expensive and considering how easily some efforts at stealth could be countered, most participants fell somewhere between defeating the endgame (i.e., preventing weapons homing or detonation) and preventing targeting by stressing affordable signature reduction, hence the cross-hatched lighter red coloring over the "Prevent Targeting" cell and the dark red coloring over the lesser included portions of this pie-shaped section of the chart. If all three types of LCS mentioned in the report are pursued, then Type B LCS should place more stress on stealth than either Types A or C. As noted earlier, for the integration workshop we divided signature concerns into two areas: above and below water signature concerns.

Participants indicated that the threshold target for *below water signatures* should be defeating the endgame, with 68 percent indicating that as their choice. When asked about their objective target, 55 percent indicated that they would like to see sufficient signature reduction to prevent targeting. When they were asked these same questions for *above water signatures*, 69 percent indicated their threshold target would be defeating the endgame and 58 percent indicated their objective target would be preventing targeting.

Endurance

We were surprised when participants at every workshop favored the LCS having an on station or independent steaming endurance of at least four weeks. As noted earlier, this desire for long endurance was not as strongly held in the integration workshop as desires for other capabilities. In fact, it finished last in the voting. In order to achieve the best possible endurance, it appears that the LCS must have a dual propulsion system that permits efficient, low speed steaming and loiter as well as a high top end sprint speed. It also means the ship must have enough stores for extended operations. Participants at the integration workshop indicated their threshold target would be two weeks (with 62 percent selecting that number), while their objective target would be 4 weeks (with 76 percent selecting that number).

Speed

During the initial workshop, the value of speed was openly questioned. As the mission area workshops proceeded, participants provided numerous justifications for a fairly high speed vessel, but few participants believed that 50 knots should be a hard target. Most participants favored speeds between 40 and 50 knots for short periods of time (hours, not

days). Even though speed fell near the bottom of the votes at the integration workshop, those favoring high speeds are a vocal and unwavering minority. It may be a political reality that the ship has to achieve 50 knots, but for our working groups it was certainly not a highly valued operational requirement. When asked for their speed targets, integration workshop participants indicated that 40 knots was their threshold target (with 64 percent selecting that number). Consistent with the relatively low value placed on speed, the majority of those not voting for a 40 knots threshold voted for a slower, not faster speed, with 24 percent voting for 30 knots and only 12 percent voting for 50 knots. When asked what their objective (desired) target for speed was, they indicated 50 knots (64 percent), with 18 percent selecting 60 knots and the same percentage selecting 40 knots.

Sensors

We tried to get a sense from participants about how far out organic sensors needed to be effective. This was important because most participants believed that the ship must have a reduced visual signature (meaning a low profile), which could greatly reduce sensor range. Although some participants did believe the ship should possess the ability to conduct broad area surveillance, most were convinced that access to such information was more important than having an organic ability to sense at long-range. On the other hand, all participants believed that the ship needed to have coverage sufficient for self-defense. Some missions (especially, small boat prosecution, MIO, and special operations) required more than point defense sensors. These sensors, however, need not be on the ship to the extent they can be carried by manned or unmanned vehicles carried by the ship. We specifically asked integration workshop participants for their sensor target ranges. When asked about threshold sensor ranges, they were evenly split between point defense and local area sensors (48 percent each). When queried about their objective (desired) sensor ranges, 70 percent of them indicated they preferred local area sensors, with 24 percent indicating they preferred broad area sensors.

Range

Across every workshop there was a consistent belief that the LCS should be capable of crossing the Atlantic Ocean or reaching Hawaii from the West Coast unrefueled. It was clear at the integration workshop, however, that range, endurance, and speed were the three areas in which participants felt there was a great deal of tradespace. When asked for their threshold range target, 39 percent indicated that the ship should have a 3000 nautical mile range, with 27 percent indicating a 2000 nautical mile range, and another 24 percent indicating a preference for a 4000 nautical mile range. When asked for their desired (objective) range, 70 percent indicated they preferred 4000 nautical miles. The other votes were spread from 1000 to 6000 nautical miles.

Organic weapons

Although some participants believed that weapons carried by manned or unmanned systems on the ship should be considered "organic," we interpreted organic weapons to

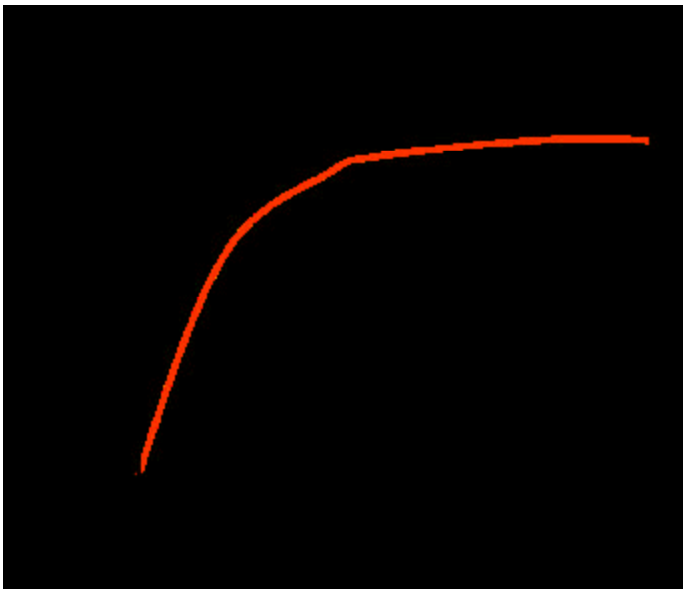
mean onboard systems, especially since few unmanned systems exist and some people (though less than half our participants) believe the LCS should not support an organic helicopter. Few participants believed the ship should be unarmed, and only a few more believed that it should be capable of conducting over-the-horizon attacks, including land attack. Although there was a consensus during the mission area workshops that point defense systems were a must, participants also accepted the reality that point defenses were insufficient to defeat all littoral risks. For that reason, a medium caliber gun, a defensive missile, and a vertical launch system capable of carrying a variety of defensive and offensive weapons were favorite candidates of most participants. At the integration workshop, participants were consistent in matching weapons to sensors. They split their threshold target vote for organic weapons between point defense (55 percent) and local area (45 percent) weapons. When asked about their objective (desired) target for organic weapons, 64 percent indicated they preferred local area weapons, while another 33 percent indicated they preferred broad area (over-the-horizon) weapons.

Connectivity

The range of connectivity we offered participants started with administrative connectivity (messages and emails) up to a robust node capable of real-time connectivity with others despite the scenario. Most mission area participants indicated that as a minimum they needed tactical connectivity with other US Navy assets, but many believed that the promise of network centric warfare would not be realized if the LCS fell short of full joint tactical connectivity. Although integration workshop participants had great difficulty defining exactly what particular levels of connectivity really meant, they established as their threshold target something between Navy tactical connectivity (39 percent) and Joint tactical connectivity (55 percent). They established Joint tactical connectivity (67 percent) as their objective target, with the other 33 percent of participants preferring the more robust coalition tactical connectivity.

We had more difficulty deciding how to describe the levels of connectivity than the levels of any other characteristic. We settled on this breakdown based on discussions with command and control experts and a study by Paul Davis in which he concluded that "not all interoperability is equally important."[2] Davis was looking primarily at coalition operations, but his general observations are more widely applicable. He drew the following figure to underscore his point.

[2] Paul K. Davis, "Transforming the Armed Forces," in The Global Century: Globalization and National Security, volume 1, edited by Richard L. Kugler and Ellen L. Frost (Washington, DC: National Defense University Press, 2001), p. 437.



The bottom line is that participants believed strongly in connectivity, but demonstrated a healthy skepticism that LCS would be a full-up network centric vessel when it first becomes operational. Their desire is for a ship that can be connected to networks as they become available. Since connectivity means bandwidth, the ship should be designed with plenty of it — this will permit the ship to transform as new capabilities emerge. They also recommended that most of the analysis be done on the offboard sensors (increasing their cost), which then broadcast back only essential information, thereby greatly reducing bandwidth demand.

Aviation

Aviation capabilities, more than any other area except perhaps speed, sparked impassioned debate. Operators who had deployed on ships that didn't support helicopter detachments warned that this was a mistake. On the other hand, proponents of Type B LCS argued that planning for a ship with other than lily pad capability would make the ship too large and expensive to be transformational. In the end, nearly two-thirds of mission area workshop participants believed the ship should be designed to support an organic helicopter. Virtually no one believed it should have no helicopter capability. This sentiment was mirrored during the integration workshop, where participants were asked to consider helicopters as surrogates for UAVs. When asked for their threshold capability, 58 percent indicated the LCS should support an organic helicopter, while 40 percent indicated it should only host lily pad operations. This changed significantly when asked for their desired air capability. Fifty-eight percent indicated they preferred the LCS to support two organic helicopters, with another 40 percent indicating it should host a single organic helicopter.

Rigid-hull inflatable boats

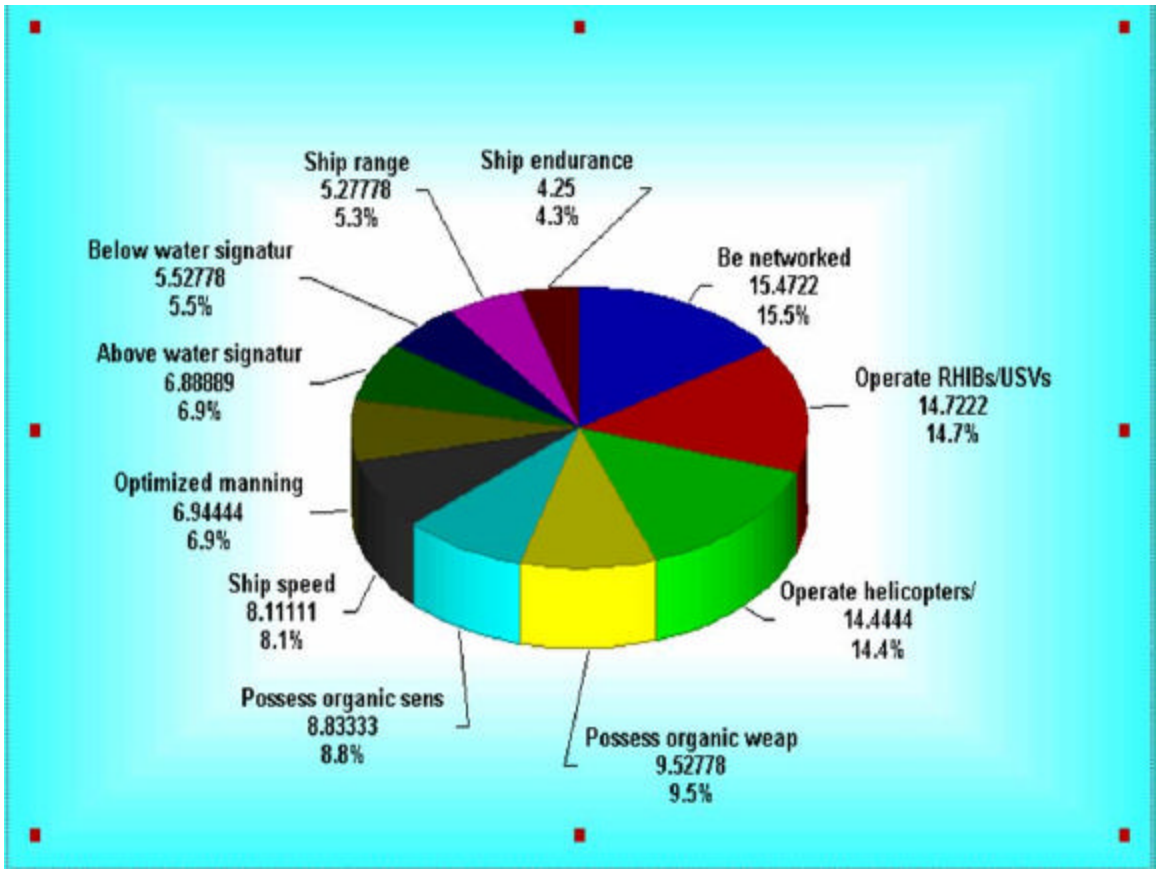
We selected rigid hull inflatable boats as an important characteristic since they currently support numerous missions and can serve as surrogates for unmanned surface vessels

currently under development. Since both MIO and special operations workshop participants indicated that two RHIBs were the minimum required to conduct these missions, two was accepted as the standard. Integration workshop participants took our suggestion to consider RHIBs as USV surrogates seriously, and surprised us by indicating the LCS should support many more than two we suggested. For example, when asked to establish a threshold level of support, 36 percent indicated the threshold should be 3, 45 percent indicated it should be 5, and 15 percent indicated it should host as many as 8 RHIBs/USVs. When asked about their desired level of support, 39 percent indicated they preferred 5, 18 percent indicated they preferred 8, and 36 percent indicated they preferred 10 RHIBs/USVs. Participants did not simply ignore the 11-meter RHIB footprint, they indicated they were supporting the development of smaller UAVs so that the ship could support more of them in the same space initially utilized by two or three 11-meter RHIBs.

Final thoughts

This report was prepared in response to the N76 tasking to develop the characteristics of a single LCS. That is how we interpreted our tasking, and so that is how we proceeded. That is also how participants at the integration workshop viewed the tasking and they called the Type C LCS the 80 percent solution. Like us, however, they were neither deaf nor blind to the arguments and proposals being raised elsewhere. In fact, we tried to expose them to as many of those arguments and proposals as we could. This was to ensure that promising alternatives were included and that workshop participants who were proponents of these other concepts felt their views were heard. As noted in the introduction, after sorting out the discussion, we believed we heard three distinct variants of LCS being discussed. A summation of the arguments in support of each of the three alternatives is found below.

We also wanted to give participants at the integration workshop the opportunity to weight various characteristics against one another, believing that real direction is only provided when people are forced to make impossible choices (like what is more important to you, weapons or sensors?). The following pie chart indicates the cumulative investment participants made when asked to allocate $100 among the 11 characteristics presented during the workshop. The actual percentages are of less significance than the relative values. For example, participants believe that the real trade space for the LCS is found in the ship's endurance, range, and speed — certainly not a conclusion one would reach from what one reads in the press -- with connectivity deemed almost twice as important as speed.



We conducted the head-to-head (pairwise) comparisons in order to verify that the group was being internally consistent in how it rated the various characteristics. This is how the rankings turned out under the two rating methods:

Allocation Exercise

1. Connectivity (15.5%)
2. Operate RHIBs/USVs (14.7%)
3. Operate helos/UAVs (14.4%)
4. Signature reduction (combined 12.4%)
5. Possess organic weapons (9.5%)
6. Possess organic sensors (8.8%)
7. Ship speed (8.1%)
8. Optimized manning (6.9%)
9. Ship range (5.3%)
10. Ship endurance (4.3%)

Pairwise Comparisons

1. Connectivity (won 8 of 9 pairings)
2. Operate RHIBs/USVs (won 8 of 9)
3. Operate helos/UAVs (won 8 of 9)
4. Possess organic sensors (won 6 of 9)
5. Possess organic weapons (won 5 of 6)
6. Signature reduction (won 4 of 9)
7. Ship speed (won 2 of 9)
8. Optimized manning (won 2 of 9)
9. Ship range (won 1 of 9)
10. Ship endurance (won 0 of 9)

Overall one would have to conclude that integration workshop participants were highly consistent in their votes.

LCS Variants

As discussed throughout this report, we found it difficult to reconcile the three types of LCS concepts that were discussed during the workshops. Some integration workshop participants believed that proposing three variants was tantamount to punting the ball back into the Navy Staff's end of the field, while others were just as adamant that it was too early to foreclose promising alternatives. After all was said and done, we decided to go forward with the three options for the reasons described below.

Type A LCS, as represented by a modified High Speed Vessel, is likely to enter the fleet in some form. It is being pushed hard by the Navy Warfare Development Command, which has come out with a "business plan" for implementing their vision. It represents the vessel used primarily as a conveyance for sensors and weapons that was often raised during LCS discussions. The fact remains, however, that many of the war fighting systems (e.g., ASW and MCM off-board systems and sensor grids) this variant is supposed to carry into the littoral don't currently exist. Fortunately, the HSV has logistics and C2 utility right now and so buying a number of them, equipped with proper handling and stowage gear for small craft and helicopters, as well as other changes as suggested by NWDC, makes some sense.

Type B LCS comes closer to the ship envisioned by SURFPAC and is better suited to some mission areas (such as special operations, dogfighting with small craft, and intelligence preparation of the battlefield preparation). We agree with most workshop participants, however, that sustainability challenges with a small ship are significant and the bulk of littoral combat ships might not be of this type. Because of its size limitations, Type B probably should deploy in conjunction with a support vessel, perhaps a Type A LCS, which could help it overcome some of the challenges associated with its smaller size. We do not believe these ships should be built with the concept of supporting them at shore bases in or near the conflict. We feel that such a concept gives up (at least in part) one of the Navy's great strengths, namely the ability to operate independently of near-by friendly and secure bases. Type B could be similar to Sweden's *Visby* or an up-scaled version of Norway's *Skjold*, with focus on stealthy technology and high speed and short-range onboard weapons. The *Visby* is long on stealth and shorter on speed (40 knots), while the *Skjold* is long on speed and shorter on payload.

Type C LCS satisfies the majority of requirements established at the outset of this process. It is a ship with real capability, fills a very real force structure requirement, and is transformational. Current systems that participants recommended be used on this type LCS to ensure near-term war fighting capability from the outset can also act as surrogates for future systems. For example, helicopters serve as a substitute for unmanned aerial vehicles. Spaces (like hangars) provided for organic helicopters will prove useful for housing newer systems when they come on line. RHIBs are an excellent substitute for unmanned surface vehicles under development, and the Remote Minehunting System is a good substitute for learning to operate the next generation of unmanned underwater vehicles. As envisioned, nothing about the ship makes it obsolete as new systems become available. In fact, we think the transition from current to new systems would be smooth,

and more importantly deliver a ship capable of immediately carrying out the critical war fighting missions it has been assigned.

The Navy is already exploring vessels that could fill each niche (i.e., HSV, *Skjold*, and *Triton*) and Sweden is moving ahead with the *Visby* class. In general, continuing to consider all three types of LCS could simultaneously increase force structure, satisfy transformation advocates, and help fill operational gaps — the three purposes for which we believe the littoral combat ship process was begun.

As reported in the introduction, integration workshop participants did not support our recommendation to move ahead with all three variants. Forty-seven percent of integration workshop participants recommended that the Navy move forward with only two of the variants. Most of those who voted for two variants believed that Type A was not an LCS but a logistics ship, and they favored pursuing Types B and C. Others believed that Type C was a step too far and preferred to see Types A and/or B evolved into a Type C as technologies mature. Thirty-eight percent recommended pursuing a single ship type, believing that the Navy will not commit sufficient resources to pursuing more than one variant. Approximately 15 percent of participants agreed with our recommendation to pursue all three options.

If the Navy Staff follows the recommendation to pursue two types, integration workshop participants voted Types C (86%) and Type B (69%) as their two favorites. By contrast, only 44 percent voted Type A into the two top spots. If the Navy staff pursues a single type, participants recommend Type C (58%), with 22 percent recommending Type A and 19 percent recommending Type B, as noted in the chart contained in the introduction.

We recognize that LCS is a fast moving train and that some decisions may already have been made on some of the issues considered in this report. However, given the high stakes involved for those who will serve on LCS ships and for the Navy's effectiveness in future conflicts, we hope the careful analysis of the broad and diverse expertise of the study participants who informed these findings and recommendations will receive due consideration in deciding the future direction of LCS development.

Appendix A
Navy Staff
Littoral Combat Ship, Flight 0
Guidance

“The CNO and others have also provided some early decisions on the definition of those first two test ships. ... These decisions include the following”

- ? lily pad for H-60
- ? full support to embarked OH-58Us
- ? transit without payload, at most economical speed, not in company with battle group
- ? 220M$ for construction of ship, not to include payload
- ? stay in theater for 2-3 years
- ? give up endurance for capability
- ? may accompany [battle group] in theater
- ? 1000 to 2000 tons displacement
- ? focus on crew, survivability, as in a fighter aircraft
- ? damage control – focus on aviation firefighting
- ? signature control – some
- ? 2 [Close-in Weapon Sytem] 1Bs
- ? Nulka
- ? no onboard ASW weapons or sensors, except NIXIE
- ? nav[igation] radar
- ? [Cooperative Engagement Capability], receive only
- ? [Electro-optical] sight
- ? minor caliber gun, fairly cheap
- ? radar – not ready to specify just yet
- ? air control [capable]
- ? no steel, aluminum ship (first two)
- ? sprint speed of 50 kts
- ? no basing assumptions provided
- ? want study to define UAVs, offboard vehicles
- ? NetCentric connectivity (whatever that means)
- ? R[H]IBs
- ? goal – get as much mission capability into first two ships as possible, within above guidelines
- ? plug and play – pursue the concept

Appendix B
Commander, Naval Surface Forces Pacific
message concerning the Littoral Combat Ship

ROUTINE
R 010200Z MAR 02 ZYB PSN 236646L27
FM COMNAVSURFOR SAN DIEGO CA//N00//
TO NAVWARCOL NEWPORT RI//00//
NAVWARCOL NEWPORT RI//00//
INFO COMFLTFORCOM NORFOLK VA//N00/N01/N8//
CINCPACFLT PEARL HARBOR HI//N00/N01/N83//
CINCPACFLT PEARL HARBOR HI//N00/N01/N83//
COMNAVSURFLANT NORFOLK VA//N00/N01/N8//
CNO WASHINGTON DC//N76/N763//
CNO WASHINGTON DC//N76/N763//
COMNAVSEASYSCOM WASHINGTON DC//N00/N53C/N05//
CNR ARLINGTON VA//N00/N33//
CNR ARLINGTON VA//N00/N33//
CNA ALEXANDRIA VA//JJJ///
PEO THEATER SURFACE COMBATANTS WASHINGTON DC//PMS400B//
PEO SURFACE STRIKE WASHINGTON DC//PMS500//
COMNAVWARDEVCOM NEWPORT RI//N3/N8/N9//
NAVPGSCOL MONTEREY CA//03//
NAVPGSCOL MONTEREY CA//03//

BT
UNCLAS //N08000//
THIS IS A 2 SECTION MESSAGE COLLATED BY DMDS

MSGID/GENADMIN/COMNAVSURFOR//
SUBJ/LITTORAL COMBAT SHIP (LCS) CONCEPT DEVELOPMENT//
POC/FORD, M/CDR/CNSP N8A/TEL: 619-437-3142/DSN: 577-3142/
EMAIL: FORD.MICHAEL@CNSP.NAVY.(SMIL).MIL//
RMKS/1. THE PURPOSE OF THIS MESSAGE IS TO PROVIDE INITIAL INPUT ON LCS ROLES AND MISSIONS, WARFIGHTING CHARACTERISTICS, AND OPERATIONAL CONCEPTS. THESE PRELIMINARY IDEAS ARE INTENDED TO PROVIDE FOOD FOR THOUGHT AND DISCUSSION DURING THE UPCOMING LCS CHARACTERISTICS WORKING GROUP TO BE HELD AT THE NAVAL WAR COLLEGE 4-5 MAR.
2. BROAD CONCEPT. LCS IS ENVISIONED TO BE A FAST, AGILE, STEALTHY, RELATIVELY SMALL AND AFFORDABLE SURFACE COMBATANT. ITS WARFIGHTING CAPABILITIES SHOULD BE OPTIMIZED FOR VERSATILITY IN THE LITTORALS FOR ANTI-ACCESS AND “GAPFILLER” MISSIONS AGAINST ASYMMETRIC THREATS. A DEFINING CHARACTERISTIC SHOULD BE EXTENSIVE RELIANCE ON A VARIETY OF ORGANIC UNMANNED VEHICLES. THE SHIP SHOULD LEVERAGE TRANSFORMATIONAL WEAPONS, SENSORS, DATA FUSION, C4ISR, MATERIALS, HULL DESIGN, PROPULSION, “SMART” CONTROL SYSTEMS, OPTIMAL MANNING CONCEPTS, AND SELF-DEFENSE SYSTEMS TO ENABLE IT TO SURVIVE AND THRIVE IN AN ADVERSE LITTORAL ENVIRONMENT.
3. ROLES AND MISSIONS. THE LITTORAL ENVIRONMENT IS ENEMY-FRIENDLY. IT IS CONGESTED, WITH POTENTIAL THREATS DISPERSED AMONG BACKGROUND SHIPPING, AIR TRAFFIC, AND DIVERSE MARINE LIFE. IT IS, BY DEFINITION, AN AREA OF SHALLOW WATER AND POOR ACOUSTIC CONDITIONS. IT IS LIKELY CLOSE TO ENEMY AIRFIELDS AND PORTS. THREATS ARE CHALLENGING: MINES, DIESEL SUBMARINES, SMALL BOATS, PATROL CRAFT, LOW-SLOW FLYERS, SHORE FIRES, AND ANTI-SHIP CRUISE MISSILES. PRIMARY MISSIONS FOR THE LCS SHOULD BE THOSE THAT ENSURE AND ENHANCE FRIENDLY FORCE ACCESS TO LITTORAL AREAS. ACCESS-FOCUSED MISSIONS INCLUDE MCM, SHALLOW-WATER ASW, AND COUNTER SMALL BOAT ATTACK. THESE ARE ENABLING MISSIONS THAT WILL ALLOW LCS TO LEAD THE WAY INTO OR THROUGH A CHOKE POINT, SLOC, OR AOA FOR FOLLOW-ON NAVAL FORCES. LCS CHARACTERISTICS AND CAPABILITIES SHOULD ALSO MAKE IT WELL-SUITED TO “GAPFILLER” MISSIONS, ALLOWING COMMANDERS

TO SAVE CG'S AND DDG'S FOR HIGH END MISSIONS SUCH AS TMD AND LAND ATTACK. GAPFILLER MISSIONS MIGHT INCLUDE MIO, SLOC PATROL AND INTERDICTION, NEO AND AMPHIB RAID SUPPORT, SOF INSERTION AND EXTRACTION, LEO, OPDEC, COMBAT SAR, AND RADAR PICKET. ADDITIONALLY, LCS SHOULD UTILIZE A "PLUG AND PLAY" CAPABILITY WHICH WOULD READILY ALLOW THE WARFARE COMMANDER TO CUSTOMIZE LCS FOR A PARTICULAR MISSION, ENHANCING OR REDUCING SENSORS AND CAPABILITIES AS REQUIRED.

4. SPEED AND AGILITY. IN ORDER TO SURVIVE AND ACCOMPLISH ITS MISSIONS, LCS MUST BE CONSIDERABLY FASTER AND MORE AGILE THAN CURRENT SURFACE COMBATANTS. THE SPEED AND AGILITY OF LCS WILL BE CRITICAL FOR EFFICIENT AND EFFECTIVE CONDUCT OF THE LITTORAL MISSIONS ENVISIONED ABOVE. FURTHER, THE SURVIVABILITY OF LCS WILL DEPEND IN PART ON ITS SPEED, MANEUVERABILITY, AND STEALTHY DESIGN. HOWEVER, LCS DOES NOT NECESSARILY HAVE TO BE CAPABLE OF SUSTAINING ITS TOP SPEED FOR EXTENDED PERIODS. IT MAY BE SUFFICIENT THAT IT BE ABLE TO CRUISE AT 30 KNOTS AND SPRINT AT 50 KNOTS - POSSIBLY TO AVOID A SMALL BOAT OR SUB THREAT, INTERCEPT A POTENTIAL TERRORIST SMUGGLING VESSEL OVER THE HORIZON, OR RETIRE FROM A SOF EXTRACTION MISSION. THE REQUIREMENT FOR SPEED MAY NECESSITATE TRADEOFFS IN SIZE AND WEIGHT OF PERMANENTLY INSTALLED WEAPONS SYSTEMS.

5. UNMANNED VEHICLES (UV'S). BECAUSE SIZE, SPEED, TOPSIDE WEIGHT, FUEL, AND AFFORDABILITY CONSIDERATIONS WILL LIMIT SHIP-LAUNCHED WEAPONS AND SENSORS, LCS IS ENVISIONED TO MAKE EXTENSIVE USE OF A VARIETY OF ORGANIC UNMANNED AERIAL VEHICLES (UAV'S), UNMANNED SURFACE VEHICLES (USV'S), AND UNMANNED UNDERWATER VEHICLES (UUV'S). AN ORGANIC SYSTEM OF UV'S, FULLY NETTED TO THE SHIP, BRINGS MANY ADVANTAGES TO THE TABLE. UV'S WOULD SERVE AS BATTLESPACE EXTENDERS, ALLOWING LCS TO CONDUCT MISSIONS OVER THE HORIZON AND SUPPORT THE WAR ASHORE. THEY ARE FORCE MULTIPLIERS THAT WILL ALLOW A SINGLE SHIP TO CONDUCT A VARIETY OF MISSIONS WITH LIMITED OUTSIDE SUPPORT. LCS SHOULD PROVIDE INHERENT MODULAR-MISSION CAPABILITY THROUGH EASILY INTERCHANGEABLE UV PAYLOADS. THE MISSIONS A SYSTEM OF ORGANIC UV'S WILL ENABLE OR ENHANCE INCLUDE INTEL, RECON, SURVEILLANCE, AND TARGETING (ISRT), OTH SUW, MCM, SIGINT, COMM RELAY, CHEM/BIO RECON, EW, AND COMBAT SAR, TO NAME ONLY A FEW.

6. WARFIGHTING CAPABILITIES. BECAUSE OF REQUIREMENTS FOR SPEED AND STEALTH, NUMBER AND WEIGHT OF PERMANENTLY INSTALLED WEAPONS SYSTEMS MAY NEED TO BE MINIMIZED, WITH UV'S AND OTHER MODULAR MISSION PACKAGES PROVIDING MOST OF THE WARFIGHTING CAPABILITIES.

A. SUW

(1) UAV/USV'S WITH VARIOUS MODULAR PAYLOADS SUCH AS ELECTRO-OPTICAL/ INFRARED (EO/IR) TO PROVIDE REAL-TIME OR NEAR REAL-TIME IMAGERY; LASER TARGET DESIGNATOR/RANGE FINDER CAPABLE OF SUPPORTING WEAPONS LAUNCH; AND A TACTICAL WEAPON (E.G., HELLFIRE-LIKE WEAPON). THESE PAYLOADS WILL ENABLE DETECTION, ID, TRACKING, AND ENGAGEMENT OF SURFACE THREATS PRIOR TO THEIR WEAPONS RELEASE RANGE.

(2) ON BOARD WEAPONS MIGHT INCLUDE NEXT-GENERATION STABILIZED CHAIN GUNS, SMALL ARMS, AND FUTURE DIRECTED OR PULSED ENERGY WEAPONS.

B. USW

(1) USV/UUV'S EMPHASIZING ACOUSTIC MODULAR PAYLOADS SUCH AS SIDE-SCAN AND HIGH-FREQUENCY ACTIVE SONARS TO DETECT MINES AND LOW DOPPLER, NEAR BOTTOM SUBS IN SHALLOW, HIGH AMBIENT NOISE ENVIRONMENT.

(2) UAV'S EMPHASIZING NON-ACOUSTIC MODULAR PAYLOADS SUCH AS MULTI-SPECTRAL/HYPER-SPECTRAL CAMERA, TACTICAL SYNTHETIC APERTURE RADAR (TSAR), ADVANCED RADAR PERISCOPE DETECTION DEVICE (ARPDD), AND EO/IR.

(3) ON BOARD WEAPONS/SELF-DEFENSE SYSTEMS MIGHT INCLUDE A VERTICALLY-LAUNCHED "HEDGEHOG" TYPE OF ASW ROCKET FOR QUICK REACTION AND MOBILE, ACOUSTIC DECOYS.

C. OTHER SELF-DEFENSE SYSTEMS.
(1) ON BOARD HARD KILL/ACTIVE SYSTEMS MIGHT INCLUDE FIXED VERTICALLY-LAUNCHED AIR DEFENSE WEAPONS AS WELL AS MAN PORTABLE MISSILES (E.G., STINGER-LIKE) FOR AIR AND SMALL BOAT DEFENSE.
(2) ON BOARD SOFT KILL/PASSIVE SYSTEMS COULD INCLUDE BOTH ACTIVE AND PASSIVE DECOYS, ECM WITH POTENTIAL FOR DYNAMIC SIGNATURE CONTROL, AND TOWED ACOUSTIC DECOYS (E.G., NIXIE-LIKE DEVICE).
D. ON BOARD SENSORS. ON BOARD SYSTEMS WOULD LIKELY INCLUDE ESM, SURFACE SEARCH RADAR, PERISCOPE DETECTION, CBR DETECTION (E.G., CAPDS, AN/KAS-1, M31E1 BIOLOGICAL INTEGRATED DETECTION SYSTEM (BIDS)), MAST MOUNTED SIGHTS (E.G., FLIR, NIGHT VISION, ELECTRO-OPTICAL, LASER RANGE FINDER), AND 2D AIR SEARCH RADAR. OTHER POSSIBILITIES: SMALL SCALE 3-D AIR SEARCH RADAR, TOWED ARRAY, TOWED ACTIVE SONAR.
E. C4ISR/INFORMATION WARFARE. IN ORDER TO ENHANCE THE CAPABILITY TO COLLECT, PROCESS, AND DISSEMINATE INFORMATION AND CONDUCT OTH ISRT MISSIONS, LCS CONCEPT DEVELOPMENT SHOULD CONSIDER THE CNO STRATEGIC STUDIES GROUP (SSG) FORCENET CONCEPT. FORCENET IS DEFINED AS “THE ARCHITECTURE AND BUILDING BLOCKS OF SENSORS, NETWORKS, DECISION AIDS, WEAPONS, WARRIORS, AND SUPPORTING SYSTEMS INTEGRATED INTO A HIGHLY ADAPTIVE, HUMAN-CENTRIC, COMPREHENSIVE SYSTEM THAT OPERATES FROM SEABED TO SPACE, FROM SEA TO LAND.” IT ENVISIONS A SEABED-TO-SPACE, MULTI-TIERED SENSOR GRID, INTEGRATED INFORMATION SYSTEMS, INFORMATION CONVERTED TO ACTIONABLE KNOWLEDGE, AND DISTRIBUTED COMBAT CAPABILITY (BOTH MANNED AND UNMANNED) TO ENABLE A FULLY PREPARED AND INFORMED WARRIOR. THE NAVAL FIRES NETWORK (NFN) AND OTHER POTENTIAL SYSTEMS SHOULD BE EXPLORED FOR ABILITY TO PROVIDE TIME CRITICAL TARGETING AND INFO SUPERIORITY. DATA FUSION TECHNOLOGIES THAT ENHANCE DECISION MAKING AND COMBAT ACTION IN A REDUCED MANNING ENVIRONMENT ARE ESSENTIAL TO MAKING LCS A VIABLE PLATFORM IN A FUTURE OF REDUCED FINANCIAL RESOURCES. LCS MUST BE ABLE TO LEVERAGE ALL AVAILABLE INFORMATION WITHOUT REQUIRING AN INORDINATE NUMBER OF ORGANIC SENSORS AND WITH MINIMAL/OPTIMUM MANNING.
7. HULL CONFIGURATION. HULL DESIGN TRADE-OFF CONSIDERATIONS SHOULD BALANCE NEEDS FOR HIGH-SPEED DASH CAPABILITY, ENDURANCE, SIZE, SEAKEEPING, AND STEALTH. SPECIFIC REQUIREMENTS:
A. STEALTH. STEALTH WILL COMPLICATE THE ENEMY’S ISR AND TARGETING SOLUTIONS, ENHANCE SURVIVABILITY, AND FACILITATE CERTAIN MISSIONS SUCH AS SOF INSERTION AND EXTRACTION. TOPSIDE DESIGN SHOULD PROVIDE A SMALL RADAR CROSS-SECTION THROUGH USE OF COMPOSITE MATERIALS AND A MULTI-SPECTRAL STEALTHY CONFIGURATION. IN ADDITION, DESIGN SHOULD ALLOW FOR MISSION STEALTH CAPABILITY SUCH AS AN ENCLOSED “MOON POOL” CAPABILITY FOR SOF INSERTION OPERATIONS.
B. DRAFT. THE DRAFT MUST BE RELATIVELY SHALLOW (20 FEET OR LESS) IN ORDER TO FACILITATE SHALLOW-WATER AND NEAR-LAND EXCURSIONS.
C. AIR CAPABILITY. A FLIGHT DECK FOR OPERATING, FUELING, AND SUPPORTING UAV’S IS ESSENTIAL. LCS IS NOT ENVISIONED TO MAINTAIN A FULL AIR DETACHMENT (I.E., SH-60 DET) WITH THE SPACE/MATERIAL IMPACT AND MAINTENANCE SUPPORT MANNING THAT ENTAILS, BUT MUST RETAIN THE ABILITY TO SUPPORT HELICOPTER OPERATIONS SUCH AS REFUELING, LILLYPAD, AND VERTREP.
D. BOAT AND UV WATER-LAUNCH CAPABILITY. SHIP CONFIGURATION SHOULD ALLOW FOR SMOOTH LAUNCHING AND RECOVERY OF A VARIETY OF UUV’S, USV’S, RESCUE BOATS, AND SOF CRAFT WITHOUT THE NEED FOR DAVITS THAT ARE CUMBERSOME, ADD TOPSIDE WEIGHT, AND INCREASE RADAR CROSS-SECTION. THE MOST LIKELY SOLUTION IS THROUGH A STERN RAMP OR GATE BUT MAY ALSO INCLUDE A VARIABLE DEPTH CAPABILITY FOR LCS.

E. SHIP QUIETING. BECAUSE OF THE PREVALENCE OF MINE AND SUB THREATS IN THE LITTORALS, LCS SHOULD BE DESIGNED WITH SHIP QUIETING, NOISE MONITORING, AND EQUIPMENT SHOCK MOUNTING IN MIND.

F. AT SEA REPLENISHMENT. IN ADDITION TO VERTREP CAPABILITY INHERENT IN THE INCLUSION OF A FLIGHT DECK, LCS WILL REQUIRE AN AT-SEA FUELING CAPABILITY. THIS WOULD PROVIDE FOR INTEROPERABILITY WITH LEGACY PLATFORMS AS WELL AS ENABLE OPERATIONS WITH ALLIED NAVIES. ALSO, SINCE ALL FUTURE COMBATANTS WILL OPERATE WITH REDUCED MANNING, LCS SHOULD CAPITALIZE ON AUTOMATED AND MODULAR UNREP TECHNOLOGIES FOR ALL AT-SEA AND INPORT COMMODITY HANDLING.

8. PROPULSION AND ENGINEERING SYSTEMS. PROPULSION SYSTEMS MUST PROVIDE A HIGH SPEED CAPABILITY. HOWEVER, IN RECOGNITION OF FUEL, SIZE, ENDURANCE, AND ENGINEERING TRADEOFFS, SPEED DOES NOT NECESSARILY HAVE TO BE SUSTAINED FOR LONG PERIODS. IT MAY BE SUFFICIENT FOR LCS TO ONLY HAVE A HIGH-SPEED DASH CAPABILITY. TRANSFORMATIONAL PROPULSION AND ENGINEERING SYSTEMS, SUCH AS ELECTRIC DRIVE, SHOULD BE EXPLORED NOT ONLY TO PRODUCE HIGH SPEEDS BUT TO TAKE INTO ACCOUNT OPTIMAL MANNING CONCEPTS SUCH AS PROPULSION, ELECTRIC PLANT, AND DAMAGE CONTROL AUTOMATION AND MONITORING SYSTEMS TO SUPPORT A MINIMUM MAINTENANCE REQUIREMENT.

9. SMART SYSTEMS. TO ENHANCE MISSION ACCOMPLISHMENT AND SURVIVABILITY WITH OPTIMAL MANNING, LCS SHOULD LEVERAGE THE LATEST IN SMART SHIP SYSTEMS, INTEGRATED THROUGH A ROBUST LOCAL AREA NETWORK.

A. INTEGRATED BRIDGE SYSTEM. SYSTEMS TO CONSIDER INCLUDE AUTOMATED PILOTING, SHIP’S COURSE TRACK ANALYSIS, RADAR AND DIGITAL NAUTICAL CHART OVERLAY, ELECTRONIC NAV, AND COLLISION AVOIDANCE SYSTEMS.

B. DAMAGE CONTROL. AN AUTOMATED, REAL-TIME DC MANAGEMENT SYSTEM WILL BE ESSENTIAL.

C. WIRELESS INTERNAL COMMUNICATIONS SYSTEM. PORTABLE/HAND HELD INTRA-SHIP COMMS.

D. FUEL CONTROL SYSTEM. DIGITAL CONTROL SYSTEM FOR FUEL FILL AND TRANSFER.

E. MACHINERY CONTROL SYSTEM. AUTOMATED PROPULSION AND ELECTRICAL PLANT CONTROLS.

F. INTEGRATED CONDITION ASSESSMENT SYSTEM. AUTOMATED CONDITION BASED MAINTENANCE RECORDER FOR ENGINEERING AND COMBAT SYSTEMS EQUIPMENT.

G. INTEGRATED COMBAT SYSTEMS CONTROLS USING DATA FUSION TECHNOLOGIES.

H. ENHANCED AUTOMATED COMMUNICATIONS, INCLUDING COLLABORATIVE/CHAT NETWORKS TO AID IN DECISION MAKING.

10. ADDITIONAL POTENTIAL TRANSFORMATIONAL SYSTEM: PERSONNEL TRACKING AND MONITORING SYSTEM (PTMS). AUTOMATED SYSTEM INTEGRATED INTO SHIP’S LAN TO COMBINE MAN OVERBOARD, TRACKING, AND PHYSIOLOGICAL MONITORING TO LOCATE AND MONITOR PERSONNEL.

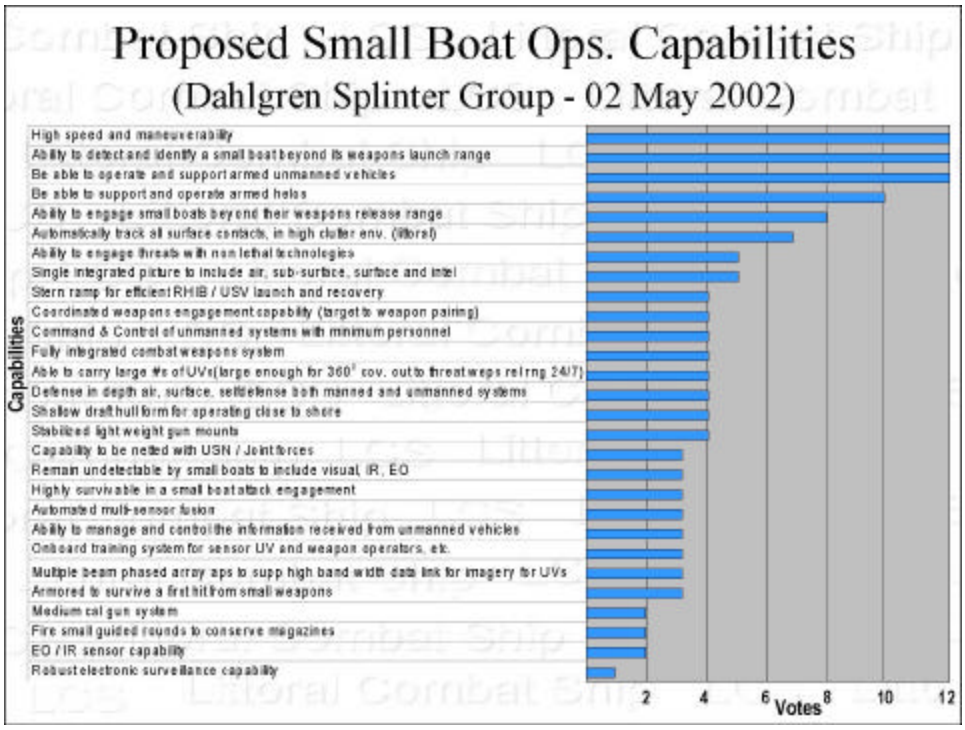
11. KEY POINTS. GIVEN THAT DESIGN TRADEOFFS MUST BE MADE, IT IS IMPORTANT TO REMEMBER TWO KEY POINTS DURING CONCEPT DEVELOPMENT:

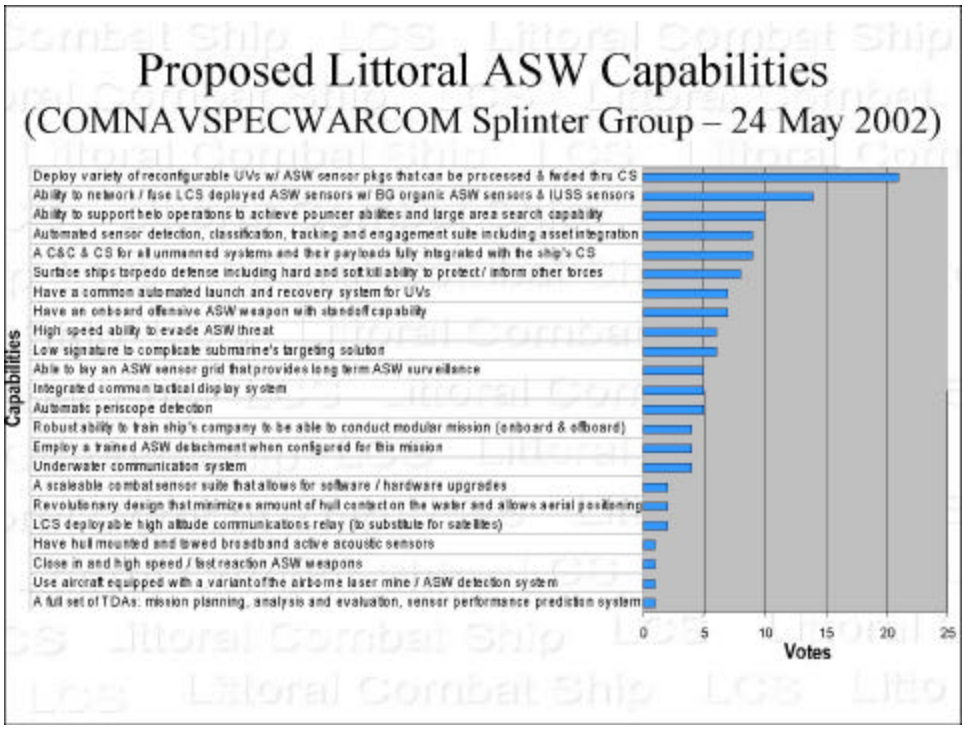
A. LET CAPABILITIES DRIVE SIZE. LCS SHOULD BE A RELATIVELY SMALL WARSHIP TO SUPPORT REQUIREMENTS FOR SPEED, AGILITY, STEALTH, AND AFFORDABILITY. HOWEVER, IT MUST BE LARGE ENOUGH TO OPERATE A WIDE VARIETY OF UNMANNED VEHICLES AND HELICOPTERS AND HAVE ENOUGH OFFENSIVE AND DEFENSIVE WEAPONS TO ENABLE THE SHIP TO CARRY OUT ITS ANTI-ACCESS MISSIONS. PRE-CONCEIVED NOTIONS OF THE SHIP’S SIZE SHOULD NOT DRIVE DESIGN TRADEOFFS THAT MIGHT ULTIMATELY LEAVE LCS UNPREPARED TO ACCOMPLISH ITS MISSIONS OR DEFEND ITSELF. WHILE SIZE IS IMPORTANT, WARFIGHTING CAPABILITIES ARE CRITICAL.

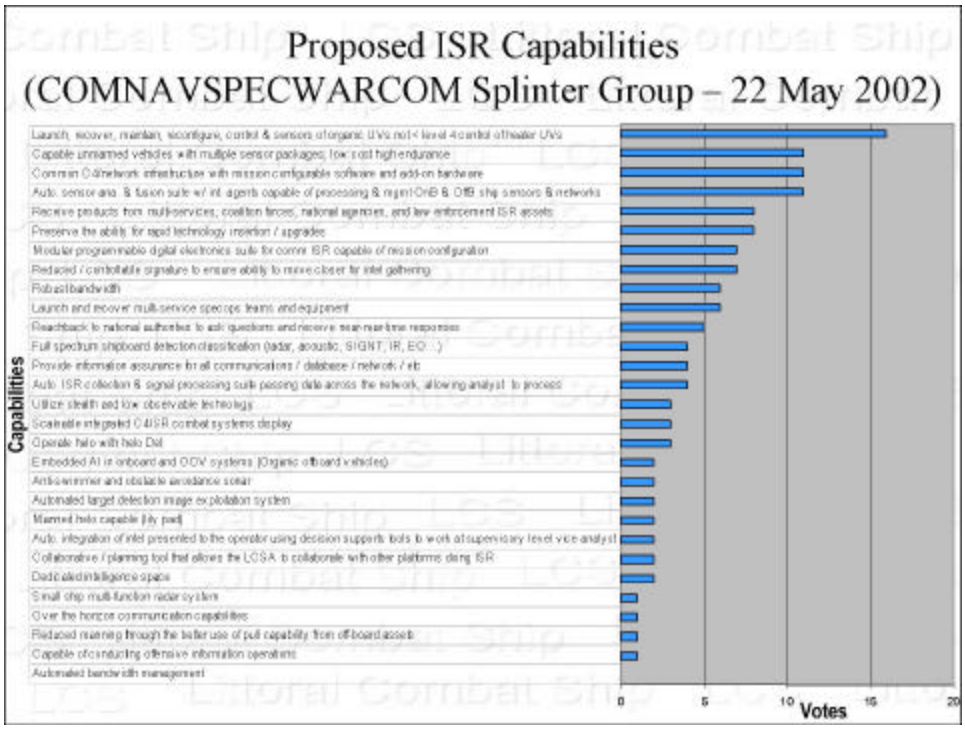
B. LCS WILL NOT BE ABLE TO DO EVERYTHING. IT IS IMPORTANT NOT TO LET LCS TURN INTO A GOLD PLATED CADILLAC, EXPECTING IT TO BE ABLE TO DO

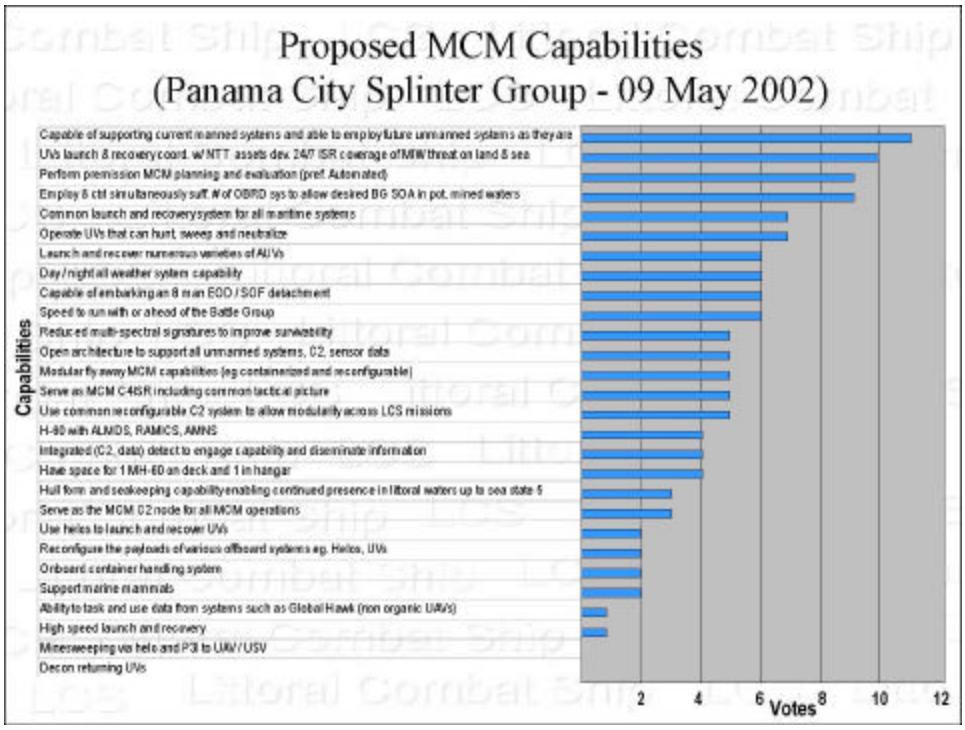
EVERYTHING A DD(X) OR CG(X) WILL BE ABLE TO DO. IT SHOULD BE VERSATILE FOR A VARIETY OF LITTORAL MISSIONS AS DESCRIBED ABOVE, BUT ITS CAPABILITIES, COST, AND SIZE SHOULD BE FOCUSED ON MEETING THE KEY MISSIONS WHILE REMAINING AFFORDABLE.// BT #1030 NNNN

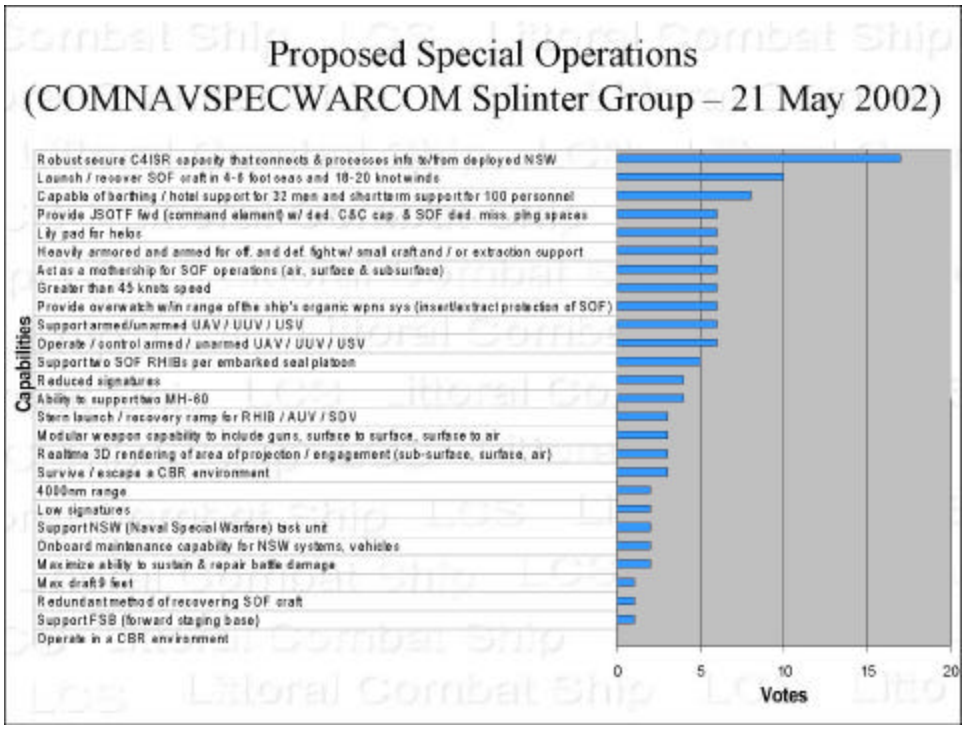
Appendix C
Mission Area Workshop Results
Prioritized Task Lists

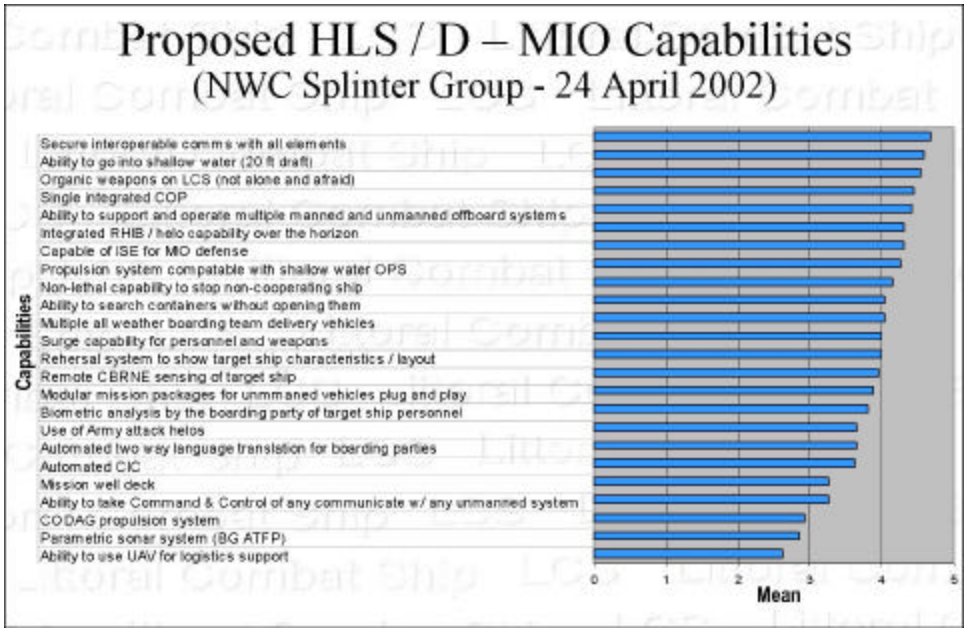

Proposed Small Boat Ops. Capabilities
(Dahlgren Splinter Group - 02 May 2002)
Capabilities
High speed and maneuverability
Ability to detect and identify a small boat beyond its weapons launch range
Be able to operate and support armed unmanned vehicles
Be able to support and operate armed helos
Ability to engage small boats beyond their weapons release range
Automatically track all surface contacts, in high clutter env. (littoral)
Ability to engage threats with non lethal technologies
Single integrated picture to include air, sub-surface, surface and intel
Stern ramp for efficient RHIB / USV launch and recovery
Coordinated weapons engagement capability (target to weapon pairing)
Command & Control of unmanned systems with minimum personnel
Fully integrated combat weapons system
Able to carry large #s of UVs(large enough for 360° cov. out to threat weps rel rng 24/7)
Defense in depth air, surface, selfdefense both manned and unmanned systems
Shallow draft hull form for operating close to shore
Stabilized light weight gun mounts
Capability to be netted with USN / Joint forces
Remain undetectable by small boats to include visual, IR, EO
Highly survivable in a small boat attack engagement
Automated multi-sensor fusion
Ability to manage and control the information received from unmanned vehicles
Onboard training system for sensor UV and weapon operators, etc.
Multiple beam phased array aps to supp high band width data link for imagery for UVs
Armored to survive a first hit from small weapons
Medium cal gun system
Fire small guided rounds to conserve magazines
EO / IR sensor capability
Robust electronic surveillance capability
2
4
6
8
10
12
Votes


Proposed Littoral ASW Capabilities
(COMNAVSPECWARCOM Splinter Group – 24 May 2002)
Capabilities
Deploy variety of reconfigurable UVs w/ ASW sensor pkgs that can be processed & fwded thru CS
Ability to network / fuse LCS deployed ASW sensors w/ BG organic ASW sensors & IUSS sensors
Ability to support helo operations to achieve pouncer abilities and large area search capability
Automated sensor detection, classification, tracking and engagement suite including asset integration
A C&C & CS for all unmanned systems and their payloads fully integrated with the ship's CS
Surface ships torpedo defense including hard and soft kill ability to protect/ inform other forces
Have a common automated launch and recovery system for UVs
Have an onboard offensive ASW weapon with standoff capability
High speed ability to evade ASW threat
Low signature to complicate submarine's targeting solution
Able to lay an ASW sensor grid that provides long term ASW surveillance
Integrated common tactical display system
Automatic periscope detection
Robust ability to train ship's company to be able to conduct modular mission (onboard & offboard)
Employ a trained ASW detachment when configured for this mission
Underwater communication system
A scaleable combat sensor suite that allows for software / hardware upgrades
Revolutionary design that minimizes amount of hull contact on the water and allows aerial positioning
LCS deployable high altitude communications relay (to substitute for satellites)
Have hull mounted and towed broadband active acoustic sensors
Close in and high speed / fast reaction ASW weapons
Use aircraft equipped with a variant of the airborne laser mine / ASW detection system
A full set of TDAs: mission planning, analysis and evaluation, sensor performance prediction system
0
5
10
15
20
25
Votes


Proposed ISR Capabilities
(COMNAVSPECWARCOM Splinter Group – 22 May 2002)
Capabilities
Launch, recover, maintain, reconfigure, control & sensors of organic UVs not< level 4 control of heavier UVs
Capable unmanned vehicles with multiple sensor packages, low cost high endurance
Common C4I/network infrastructure with mission configurable software and add-on hardware
Auto. sensor and & fusion suite w/ int. agents capable of processing & mgmt OnB & OffB ship sensors & networks
Receive products from multi-services, coalition forces, national agencies, and law enforcement ISR assets
Preserve the ability for rapid technology insertion / upgrades
Modular programmable digital electronics suite for comm ISR capable of mission configuration
Reduced / controllable signature to ensure ability to move closer for intel gathering
Robust bandwidth
Launch and recover multi-service special ops teams and equipment
Reachback to national authorities to ask questions and receive near-real-time responses
Full spectrum shipboard detection/classification (radar, acoustic, SIGNT, IR, EO ...)
Provide information assurance for all communications / database / network / etc
Auto. ISR collection & signal processing suite passing data across the network, allowing analyst to process
Utilize stealth and low observable technology
Scaleable integrated C4ISR combat systems deploy
Operate helo with helo Det
Embedded AI in onboard and OOV systems (Organic offboard vehicles)
Anti-swimmer and obstacle avoidance sonar
Automated target detection image exploitation system
Manned helo capable (dly pad)
Auto. integration of intel presented to the operator using decision supports tools to work at supervisory level vice analyst
Collaborative / planning tool that allows the LCSA to collaborate with other platforms doing ISR
Dedicated intelligence space
Small ship multi-function radar system
Over the horizon communication capabilities
Reduced manning through the better use of pull capability from offboard assets
Capable of conducting offensive information operations
Automated bandwidth management
0
5
10
15
20
Votes


Proposed MCM Capabilities
(Panama City Splinter Group - 09 May 2002)
Capabilities
Capable of supporting current manned systems and able to employ future unmanned systems as they are
UVs launch & recovery coord. w/ NTT assets dev. 24/7 ISR coverage of MIW threat on land & sea
Perform premission MCM planning and evaluation (pref. Automated)
Employ & ctrl simultaneously suff. # of OBRD sys to allow desired BG SOA in pot. mined waters
Common launch and recovery system for all maritime systems
Operate UVs that can hunt, sweep and neutralize
Launch and recover numerous varieties of AUVs
Day/night all weather system capability
Capable of embarking an 8 man EOD / SOF detachment
Speed to run with or ahead of the Battle Group
Reduced multi-spectral signatures to improve survivability
Open architecture to support all unmanned systems, C2, sensor data
Modular fly away MCM capabilities (eg containerized and reconfigurable)
Serve as MCM C4ISR including common tactical picture
Use common reconfigurable C2 system to allow modularity across LCS missions
H-60 with ALMDS, RAMICS, AMNS
Integrated (C2, data) detect to engage capability and disseminate information
Have space for 1 MH-60 on deck and 1 in hangar
Hull form and seakeeping capability enabling continued presence in littoral waters up to sea state 5
Serve as the MCM C2 node for all MCM operations
Use helos to launch and recover UVs
Reconfigure the payloads of various offboard systems eg. Helos, UVs
Onboard container handling system
Support marine mammals
Ability to task and use data from systems such as Global Hawk (non organic UAVs)
High speed launch and recovery
Minesweeping via helo and P3 to UAV / USV
Decon returning UVs
2
4
6
8
10
12
Votes


Proposed Special Operations
(COMNAVSPECWARCOM Splinter Group – 21 May 2002)
Capabilities
Robust secure C4ISR capacity that connects & processes info to/from deployed NSW
Launch / recover SOF craft in 4-6 foot seas and 18-20 knot winds
Capable of berthing / hotel support for 32 men and short term support for 100 personnel
Provide JSOTF fwd (command element) w/ ded. C&C cap. & SOF ded. miss. plng spaces
Lily pad for helos
Heavily armored and armed for off. and def. fight w/ small craft and / or extraction support
Act as a mothership for SOF operations (air, surface & subsurface)
Greater than 45 knots speed
Provide overwatch w/in range of the ship's organic wpns sys (insert/extract protection of SOF)
Support armed/unarmed UAV / UUV / USV
Operate / control armed / unarmed UAV / UUV / USV
Support two SOF RHIBs per embarked seal platoon
Reduced signatures
Ability to support two MH-60
Stern launch / recovery ramp for RHIB / AUV / SDV
Modular weapon capability to include guns, surface to surface, surface to air
Realtime 3D rendering of area of projecton / engagement (sub-surface, surface, air)
Survive / escape a CBR environment
4000nm range
Low signatures
Support NSW (Naval Special Warfare) task unit
Onboard maintenance capability for NSW systems, vehicles
Maximize ability to sustain & repair battle damage
Max draft 9 feet
Redundant method of recovering SOF craft
Support FSB (forward staging base)
Operate in a CBR environment
0
5
10
15
20
Votes


Proposed HLS / D – MIO Capabilities
(NWC Splinter Group - 24 April 2002)
Capabilities
Secure interoperable comms with all elements
Ability to go into shallow water (20 ft draft)
Organic weapons on LCS (not alone and afraid)
Single integrated COP
Ability to support and operate multiple manned and unmanned offboard systems
Integrated RHIB / helo capability over the horizon
Capable of ISE for MIO defense
Propulsion system compatable with shallow water OPS
Non-lethal capability to stop non-cooperating ship
Ability to search containers without opening them
Multiple all weather boarding team delivery vehicles
Surge capability for personnel and weapons
Rehersal system to show target ship characteristics / layout
Remote CBRNE sensing of target ship
Modular mission packages for unmmaned vehicles plug and play
Biometric analysis by the boarding party of target ship personnel
Use of Army attack helos
Automated two way language translation for boarding parties
Automated CIC
Mission well deck
Ability to take Command & Control of any communicate w/ any unmanned system
CODAG propulsion system
Parametric sonar system (BG ATFP)
Ability to use UAV for logistics support
0
1
2
3
4
5
Mean

Appendix D
Mission Area Workshops
Principal Take-aways

LCS Required Characteristics
ASW Workshop

- Desire is to exploit unattended sensors and sensors on OOVs.
- At least one organic manned helicopter needed.
- Weapons: UVs and helos, a QR standoff ASW weapon, a close in ASW weapon, and torpedo defense weapons
- Onboard sensors include radar, hull sonar (HF/MF), towed sensor, and periscope detection system
- Requires crew augmentation/specialization: (ASW is a highly perishable "art form")
- Speed principally for torpedo evasion.
- Acoustic signature control most important.

LCS Required Characteristics
ISR Workshop

- **Need open C4ISR architecture**
  - **Sensors/processors/radios need to be tied in to apertures, power, and cooling**
- **Robust networking/bandwidth/spectrum requirements**
  - **Need at least T1**
  - **Real time data exchange with UVs, offboard systems, and other platforms**
  - **Full connectivity with Joint/Allied/National/Law Enforcement**
- **Numbers of sensors and platforms important**
  - **Maximize use of offboard systems**
  - **Control of theater level UV assets desired**
- **Automated data fusion and analysis critical**
- **Persistent dwell important**
- **Equip with dedicated intel/cryptologic space with dedicated nets**
- **Practical stealth important to ISR mission**

LCS Required Characteristics
MCM Workshop

- LCS focus: area MCM search, map & avoid, and limited neutralization (punch through)
- Ability to carry, support and operate manned, remote, and autonomous unmanned vehicles mandatory
- Requires crew augmentation (MCM is still an art form) for identification and destruction (improved AUVs may eventually be good enough)
- Speed only required to get ahead of BG or SAG
- Organic MCM places equipment where it is needed sooner, but doesn't speed actual MCM process
- Embed organic MIW intel capability onboard LCS

LCS Required Characteristics
Anti-Small Boat Workshop

- Must be able to engage targets from close aboard to ranges beyond threat weapons launch range
- Fast reaction small craft, aircraft (manned and unmanned), and armed helos preferred method to counter threat
- Area and point defenses and high engagement rates against near-simultaneous multiple targets required
- Agility and burst speed of 40 to 50 knots useful for improving engagement geometry
- Must be able to receive and exploit offboard cueing, tracking and identification resources as well as organic capability
- Consider non-lethal options to temporarily neutralize potential threat

LCS Required Characteristics SOF Workshop

- Support/launch/recover SOF insertion/extraction vehicles
  - NSW RHIB (Minimum 2-boat 11m), SDV, Mk5
- Full C4I suite including SOF unique collaboration/ planning systems and radios
- Responsive close-in NSFS
- At least 1 armed helo (prefer 2)
- Visual/IR/Radar signature control important.
- Support for up to 50 SOF personnel
- Rehearsal and training space
- 45+ knots
- 2000+ NM Range/2 Weeks+ endurance
  - Need to work ahead of the main force arrival

LCS Required Characteristics MIO/HLD Workshop

- Deploy two or more boarding teams simultaneously
- Embark at least one, preferably two, helicopters
- Embark at least two RHIBs/team delivery vehicles
- Reposition at high (40+ knot) speed
- Unrefueled range of 4000 nm/30 days endurance
- Approximately 20 foot maximum draft
- Improved connectivity with relevant joint/interagency/coalition partners and boarding parties
- People intensive mission
- Shipboard weapons capable of stopping/ holding at risk noncompliant vessels (including nonlethal options)

Appendix E
Final LCS Characteristics Briefing

Littoral Combat Ship
LCS

Defining Operational Characteristics Integration Briefing

NWC LCS Effort

- Tasked by N-76 in December 2001
- Two Tasks:
  - Define operational characteristics of LCS
  - Identify promising technologies for LCS
- NWC effort is pre–AOA/ORD
- Final Report Submitted 31 July 2002

Characteristics Tasking Memo Schedule (Accelerated)

Event	NLT
• Detailed Plan	30 Jan 02
• Scope Defined	28 Feb 02
• Interim Report	14 Jun 02
• Final Report	31 Jul 02

Operational Characteristics Process

1. Workshop with fleet operators to develop preliminary LCS mission areas and overarching guidelines.
2. Follow on workshops combining fleet operators and technical experts to develop tasks for each of the mission areas.
3. Final integration workshop

Why Are We Doing This?

Is LCS:

1. A 'mission/capabilities focused' Frigate/Corvette-sized follow-on optimized for littoral environments?
2. A very small displacement, advanced technology vessel?
3. An answer looking for a question?
4. A set of littoral access capabilities that could be addressed by several types of surface ships/vessels, or by platforms other than ships?

Workshops

- **Initial workshop** (guidelines and missions)
- **Homeland Defense/Maritime Intercept Operations**
- **Small Boat Prosecution**
- **Mine Countermeasures**
- **Special Operations**
- **ISR Battlefield Preparation**
- **Antisubmarine Warfare**
- **Integration Workshop**

Involved over 200 fleet operators & subject matter experts

Candidate Missions & Follow-on Workshops

- Participants selected four primary missions:
  - Prosecution of Small Boats
  - Mine Counter-Measures
  - Shallow water Anti-Submarine Warfare
  - Intelligence, Surveillance, & Reconnaissance
- And two secondary missions:
  - Homeland Defense/Maritime Intercept Operations
  - Special Operations:
    - Direct Action
    - Strategic Reconnaissance
    - Information Operations

Guidelines

1. The ship must be capable of networking with other platforms and sensors.
2. The ship must be useful across the spectrum of conflict.
3. The ship must be able to sustain or support forward naval presence.
4. LCS System logistics, especially special requirements, must be included in each mission area discussion.
5. The ship should be capable of operating manned vertical lift aircraft.
6. The ship should operate with optimized/reduced manning.
7. The ship should use open architecture and modularity.
8. The ship should be capable of launching, recovering and operating manned, unmanned, and autonomous vehicles.
9. The ship should have core, organic self-defense capabilities.

Overarching Guidelines

The ship must be capable of networking with other platforms and sensors. 4.79

The ship should be capable of launching, recovering and operating manned, unmanned, and autonomous vehicles. 4.71

The ship should have core, organic self-defense capabilities. 4.50

The ship should use open architecture and modularity. 4.32

The ship should be capable of operating manned vertical lift aircraft. 4.00

The ship must be able to sustain or support forward naval presence. 3.96

The ship should operate with optimized/reduced manning. 3.86

LCS System logistics, especially special requirements, must be included in each mission area discussion. 3.82

The ship must be useful across the spectrum of conflict. 3.75

Score on scale of 1(no) to 5 (yes)

Guideline 1

The ship must be capable of networking with other platforms and sensors.

There was a sharp division between those who believed the LCS must be fully networked to all systems (FORCENET) and those who believed it only needs to be connected in areas directly affecting its mission performance. There was agreement that LCS will be both a user & a provider of data.

Guideline 2

The ship must be useful across the spectrum of conflict.

Although participants agreed with this statement, they didn't want this statement to imply that the ship should be a jack-of-all-trades. They believed it should be able to conduct peacetime exercises, maritime intercept operations and similar missions in times of tension, as well as carry out its wartime role.

Guideline 3

The ship must be able to sustain forward naval presence.

While there was general consensus favoring the statement, there were differences about how it should be interpreted. Some believed it means that ships must be capable of deploying with the battle group while others argued that it could be stationed forward. The former was much more strongly supported than the latter.

Guideline 4

LCS System logistics, especially special requirements, must be included in each mission area discussion.

There were heated discussions about logistics. Most believed a smaller LCS would require special handling (including special support ships) in order make it as flexible and sustainable as it will need to be.

Guideline 5

The ship should be capable of operating manned vertical lift aircraft.

Originally, this guideline was limited to helicopters, but participants didn't want to begin with any restrictions on later discussions. As the workshop progressed, it became clear that most participants believed the LCS should handle aircraft up to the size of SH-60 helicopters. There was divergence, however, about whether it should be a lily pad, or capable of supporting a detachment with most favoring the former.

Guideline 6

The ship should operate with optimized or reduced manning.

This guideline provoked sharp debate about the benefits and risks of reduced manning. Again and again issues of peripheral duties (such as launching & recovering unmanned vehicles, hotel services, damage control, and boarding parties) were raised. Those favoring reduced manning believed LCS must be highly automated. Those favoring an optimized crew appreciated the flexibility and sustainability a larger crew brings.

Guideline 7

The ship should use open architecture and modularity.

Everyone agreed open architecture, although difficult to achieve, is a goal worth pursuing. There was much more debate about the benefits of modularity. Strong support was expressed for modular ideas involving vertical launch systems and unmanned vehicles, but much less support was offered for conex box-like modular concepts because of cost, storage, maintenance, forward logistics and training.

Guideline 8

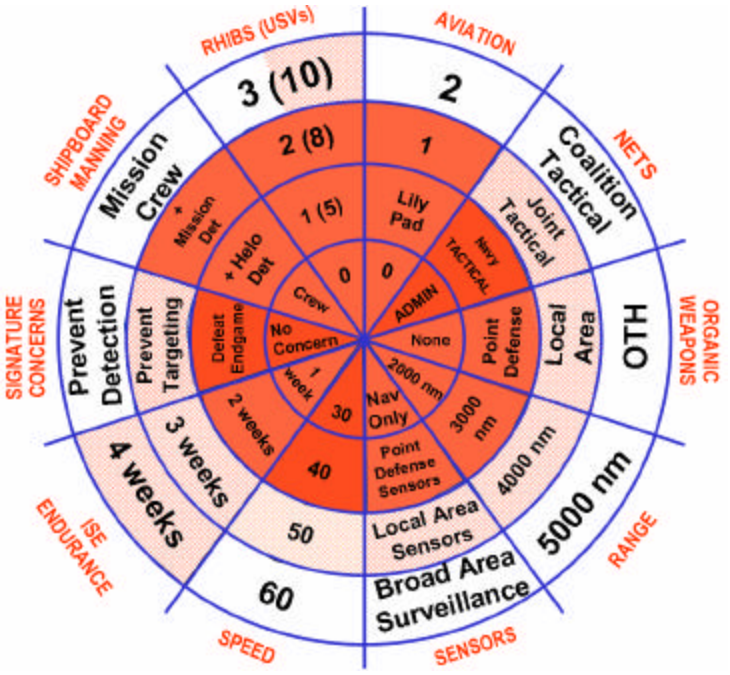
The ship should be capable of launching, recovering and operating manned, unmanned, and autonomous vehicles.

This guideline at first addressed only unmanned and autonomous systems. Special Operations representatives reminded us, however, that the LCS might be a candidate platform for launching manned vehicles they use. A lot of participants believed unmanned vehicles would be the heart of the LCS system. Big concern about when such vehicles would be ready for the fleet, leading to a discussion of a phased or evolutionary LCS design approach .

Guideline 9

The ship should have core, organic self-defense capabilities.

Participants agreed that you couldn't send a ship and its crew in harm's way and not provide some capability for self-defense. The level of this capability, however, was an issue. Most agreed that kinetic self-defense weapons are required while a few argued that stealth and speed should be its primary self-defense capabilities.

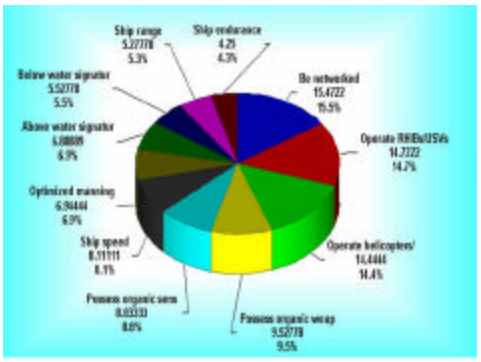


Characteristics Prioritization

Participants were asked to prioritize characteristics in two different ways:

The objective was to test participant consistency in prioritizations.

- First, they were asked to "weight" the characteristics. They were given $100 to spend on all of the characteristics. They were told that a characteristic on which they spent $20 should be considered twice as important as a characteristic on which they spent $10.
- Second, they were asked to compare characteristics head-to-head. From each pair of characteristics they were asked to select the characteristic they felt was more important – no ties and no abstentions.



1. Be networked (15.5%)
2. Operate USVs/RHIBs (14.7%)
3. Operate UAVs/Helos (14.4%)
4. Organic weapons (9.5%)
5. Organic sensors (8.8%)
6. Ship Speed (8.1%)
7. Optimized manning (6.9%)
8. Above water signatures (6.5%)
9. Below water signatures (5.5%)
10. Ship range (5.3%)
11. Ship endurance (4.3%)

Top 3 characteristics considered almost three times as important as bottom three

Pairwise Comparisons

CHARACTERISTICS (WON – LOST Record)

1. Be networked (Won 8 – Lost 1 to Operate USVs/RHIBs)
2. Operate USVs/RHIBs (Won 8 – Lost 1 to Operate UAVs/Helos)
3. Operate UAVs/Helos (Won 8 – Lost 1 to Be networked)
4. Organic sensors (Won 6 – Lost 3)
5. Organic weapons (Won 5 – Lost 4)
6. Signatures (Won 4 – Lost 5)
7. Ship Speed (Won 2 – Lost 7)
8. Optimized manning (Won 2 – Lost 7)
9. Ship range (Won 1 – Lost 8)
10. Ship endurance (Won 0 – Lost 9)

Signatures were not separated into above and below water

Dual Method Comparison

WEIGHTED PRIORITIES	PAIRWISE COMPARISONS	
1. Be networked	1. Be networked	Top 5 the same
2. Operate USVs/RHIBs	2. Operate USVs/RHIBs	
3. Operate UAVs/Helos	3. Operate UAVs/Helos	
4. Organic weapons	4. Organic sensors	
5. Organic sensors	5. Organic weapons	
6. Ship Speed	6. Above water signatures	Middle the same
7. Optimized manning	7. Ship Speed	
8. Above water signatures	8. Optimized manning	
9. Below water signatures		
10. Ship range	9. Ship range	Bottom 2 the same
11. Ship endurance	10. Ship endurance	

	Type A	Type B	Type C
Deployability	Deployable in support of the battle group	Deployable when accompanied by battle group	Deployable independent of battle group
Endurance	Range more important than endurance	Capable of short (<week) independent operations	Capable of lengthy (>month) independent operations
Helicopter ops	Supports lily pad/detachment ops	Supports lily pad operations	Supports helicopter detachment
Mission capability	Lift, support OOV mission	Single-mission	Multi-mission (sequentially)
UV operations	Complete reliance on unmanned vehicles	Controls unmanned vehicles	Supports & Operates unmanned vehicles
Logistics	Could be part of new logistics framework	New logistics framework required	Normal logistics support
Manning	Minimum manning	Reduced manning	Optimal manning
Concept of ops	Dashes in/out of littoral	Dashes in/out of littoral	Operates in littoral
Connectivity	Fully netted	Mission netted	Fully netted
Modularity	RO/RO modular	Mostly modular (single mission or module)	Highly modular (open architecture)
Stealth	Reduced signatures	Stealthy	Low signatures
Speed	High speed	Very high speed	High speed

How Many Options Should We Consider?

Workshop participants made it clear that no single ship would completely satisfy all LCS proponents

FIRST CHOICE		
1	2	3
38.8%	47.2%	13.8%

SECOND CHOICE		
1	2	3
33.3%	52.7%	13.8%

THIRD CHOICE		
1	2	3
28.7%	00.0%	72.2%

Participants were asked to rank order their preferences concerning how many variants that should be pursued

How Many Options Should We Consider?

Workshop participants made it clear that no single ship would completely satisfy all LCS proponents

FIRST CHOICE		
A	B	C
22.2%	19.4%	58.3%

SECOND CHOICE		
A	B	C
22.2%	50.0%	27.7%

THIRD CHOICE		
A	B	C
55.5%	30.5%	13.8%

Participants were asked to rank order their preference for which variant should be pursued

How Many Options Should We Consider?

Workshop participants made it clear that no single ship would completely satisfy all LCS proponents

Project leaders recommend pursuing 3 variants of LCS which together should satisfy all requirements. Integration workshop participants recommend pursuing two variants (B & C).

IF SINGLE SHIP PURSUED, PARTICIPANTS RECOMMEND TYPE C

Final Thoughts

- Report prepared with single ship type in mind (Type C – Frigate).
- Single ship type unlikely to satisfy all proponents or critics.
- Recommend pursuing two or three types, with emphasis on Type C, in order to meet greatest number of objectives and build on investments already being made by the Navy.
- Here's why we recommend that approach:

Final Thoughts

- Type A LCS, the "capability conveyor" represented by the High Speed Vessel, is focused on the lift/deployment/ recovery of OOVs mission. The ship should be properly equipped to handle and deploy unmanned vehicles, deployable sensors, and to support Type B LCS operations.
- Type B LCS, the "pouncer" represented by the Visby or Skjold, comes closer to SURFPAC's LCS concept and is a better fit for some missions (like dogfighting with small craft and delivering special forces) than either Type A or C. It's smaller size requires the support of a support vessel.
- Type C LCS, the "80% solution" represented by an upscaled Triton, is the best force structure fit for the Navy and the most useful ship in both the short- and long-term. Current systems act as surrogates for future transformational systems not yet available.